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SOLID WASTE MANAGEMENT STUDY FOR THE PORT OF TACOMA

Port of Tacoma, Washington

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Office of Solid Waste Management Programs

1973

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This study identified the source, composition, and quantities of solid waste generated at the Port of Tacoma, Washington, and determined the most efficient and practical system for storage, transportation, disposal, and processing. Three areas of solid waste management were investigated: 1) wastes routinely generated by the total Port complex and its tenants; 2) procedures used by the Port in handling waste from the terminal and shipping operations before collection by the city; 3) handling demolition waste generated by the removal of old piers and related structures. Considerable emphasis was placed on evaluating the interfacing of the Port's overall solid waste management requirements with the current planning of the City of Tacoma and Pierce County.

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for the Port of Tacoma

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1973

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I. INTRODUCTION

A. THE PORT OF TACOMA

The Port of Tacoma, one of the major harbors on the Pacific Coast, is located on Commencement Bay on lower Puget Sound in the State of Washington. The Port, a public-owned municipal corporation, occupies an area in excess of 4,000 acres, with facilities situated on the Hylebos, Blair and Sitcum waterways. Total cargo handling for 1970 amounted to about 3.3 million tons consisting of general cargo, lumber and logs, and bulk materials. By 1980, port activity is estimated to reach 6.0 million tons per year (tpy). To accommodate this increase, the Port is currently engaged in an extensive modernization and expansion program.

The Port Complex consists of:

- The Port Terminal Area (340 acres)
- The Industrial Yard (280 acres), most of which (160 acres) will subsequently be converted to additional port terminal operations
- The Industrial Development District which comprises the balance of the Port land area.

The present Port Terminal Area includes both Port-operated and leased facilities.

The marine terminal facilities include 25 operational deepwater berths; 17 acres of warehouse space for general cargo; 77 acres of open storage space adjacent to piers and storage facilities for 4.5 million bushels of wheat; 2 million cubic feet of cold storage capacity with quick-freeze facilities; and a new 1,200-foot pier (40-foot water depth) with all appurtenant facilities for bulk material handling.

A total of 146 industries of various types are presently located in the Industrial Development District. All but two of the industries now occupying the Industrial Yard area will be relocated to the Industrial Development District during the Port's current modernization program.

The location of the Port of Tacoma and the general arrangement of the Port Complex are shown on Figure I-1.

B. THE STUDY

Seaport terminals and waterfront industries present a number of special problems with respect to solid waste management. These problems, magnified by expanding Port activity and more stringent regulatory requirements, resulted in the Port's decision to engage Kaiser Engineers for assistance with the conduct of a comprehensive solid waste study.

The scope of the study encompassed three areas of investigation:

(1) Solid Waste Management for the Port Complex

The first area of investigation deals with the management of the solid waste routinely generated by the Port and its tenants, and with the existing solid waste disposal systems. This includes the total Port Complex as shown on Figure I-1. Since the Port is limited by statute to the extent it can engage in solid waste handling, this study area deals largely with the interface between the Port and local government jurisdictions responsible for solid waste management.

(2) Solid Waste Management for Port Terminal Activities

This study area concentrates on the procedures used by the Port of Tacoma in handling solid waste from terminal and shipping operations prior to collection by the City. Present and projected terminal area locations are shown on Figure I-1.

(3) Demolition Waste Management

The final study area concentrates on means of handling the demolition waste generated by the removal of old piers and related structures.

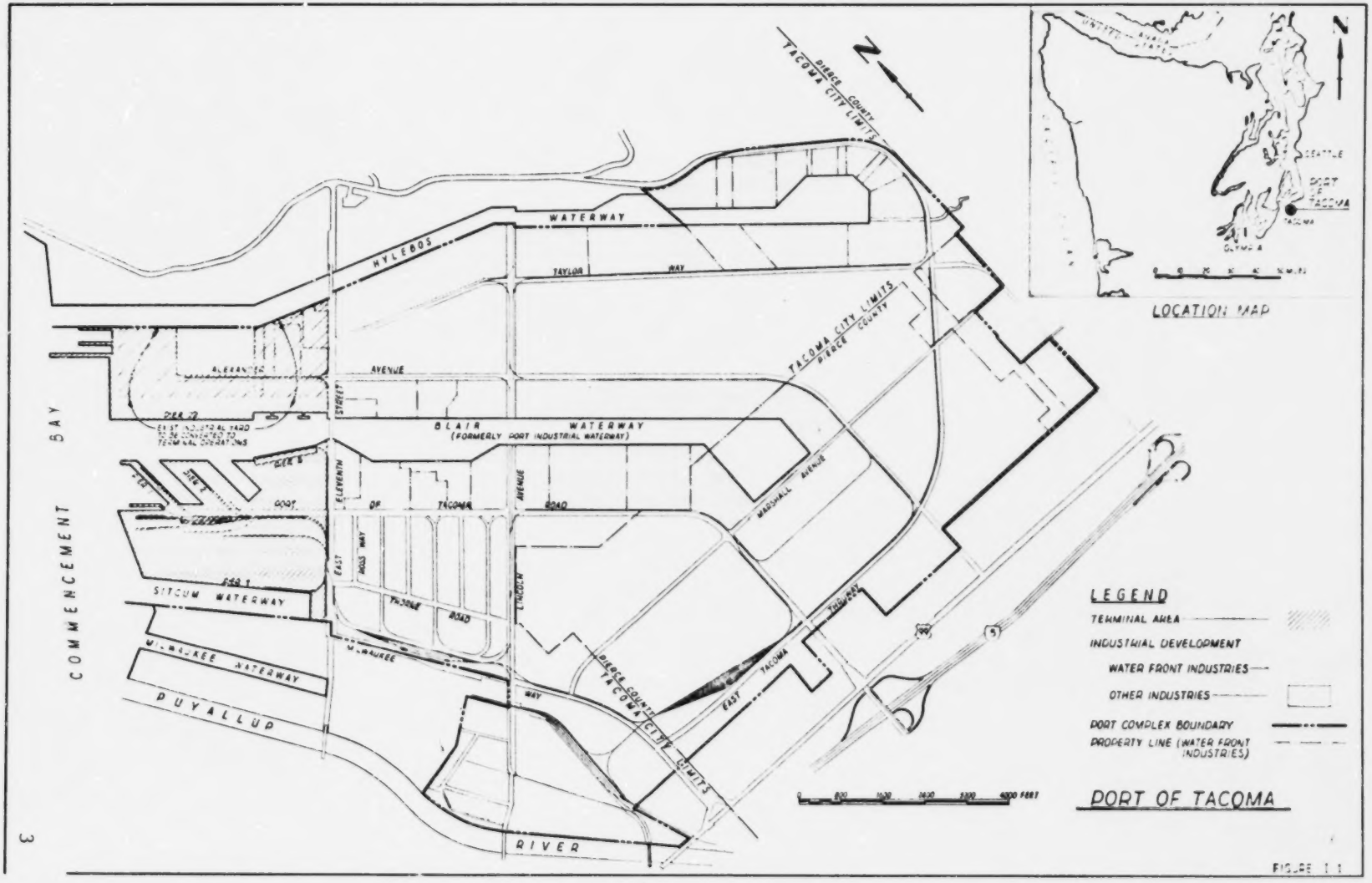
COMMENCEMENT BAY
WATERWAY
HYLEBOS
TAYLOR WAY
PIERCE COUNTY
TACOMA CITY LIMITS
ALEXANDER AVENUE
STADIUM WAY
BLAIR WATERWAY
(FORMERLY PORT INDUSTRIAL WATERWAY)
EAST 11TH STREET
PORT OF TACOMA ROAD
MARSHALL AVENUE
EAST 11TH STREET
PUYALLUP AVENUE
LINCOLN AVENUE
SITCUM WATERWAY
MILWAUKEE WAY
MILWAUKEE WATERWAY
PUYALLUP RIVER
EAST TACOMA
LOCATION MAP
SEATTLE
PORT OF TACOMA
TACOMA
OLYMPIA
LEGEND
TERMINAL AREA
INDUSTRIAL DEVELOPMENT
WATER FRONT INDUSTRIES
OTHER INDUSTRIES
PORT COMPLEX BOUNDARY
PROPERTY LINE (WATER FRONT INDUSTRIES)
PORT OF TACOMA

FIGURE 1.1

To conduct this investigation, the following tasks were identified:

- Review of present practices and procedures for solid waste handling
- Compilation of a solid waste inventory
- Development of solid waste projections for the years 1980 and 2000
- Investigation of regional planning concepts for possible solid waste management interfaces between the Port of Tacoma, the City of Tacoma and Pierce County
- Investigation of the potential for reclaiming materials from the solid waste stream
- Review of existing and proposed legislation with respect to jurisdictional and regulatory requirements.

Emphasis on areas of investigation shifted during the course of the study. Initially, pier demolition waste was identified as a critical problem. However, during the course of the study, most demolition wastes generated by current projects have been incinerated and otherwise disposed of. Major additional amounts of demolition waste are not programmed to occur before 1975. Also, statutory constraints have been determined to severely limit the Port's initiative in the implementation of traditional solid waste management systems. As a result, considerable emphasis has been placed on evaluating the interfacing of the Port's overall solid waste management requirements with the current planning of the City of Tacoma and Pierce County.

The study was conducted by members of the staff of Kaiser Engineers' Environmental Control Department with active participation by Port of Tacoma personnel assigned to the program. Mr. Ray Charles of Seattle, Washington, served as a consultant to Kaiser Engineers during the conduct of the study. The major part of the study cost was funded by a solid waste disposal study grant from the Environmental Protection Agency (EPA), Office of Solid Waste Management Programs, Demonstration Grant No. G06-EC-00344.

II. SUMMARY

A. INTRODUCTION

In 1970, Port Terminal operations and the commercial and industrial activities of the Port Complex tenants generated about 80,000 tons of solid waste. Of this amount, 43% was disposed of by off-site landfill. Thirty percent of the total, consisting of ferrous metal and selected wood waste, was salvaged for reuse. The remaining 27%, mainly mineral waste, was handled by on-site landfill.

Solid waste generated by the Port Complex is projected to increase to 139,000 tpy by 1980 and to 234,000 tpy by the year 2000. Present and projected solid waste generated within the Port Complex is estimated to account for about one-third of the solid waste generated in the Tacoma area. Terminal operations account for 4% of the total solid waste generated within the Port Complex.

In addition to the waste quantities from routine activities within the Port Complex, there are substantial quantities of solid waste generated intermittently from the demolition of old piers. In 1971, 15,000 tons of demolition waste were disposed of by on-site open-pit air-curtain incineration. Future major demolition projects are scheduled for 1975, 1980 and 1985, which will total approximately 48,000 tons.

The Port Complex area comprises about 4,000 acres. Of this area, about 63% is situated in the City of Tacoma. The remainder is in Pierce County. Essentially all terminal, commercial and industrial activities which presently generate solid waste are located within the City boundary. Much of the anticipated expansion, consisting of commercial and industrial tenants, will be in Pierce County, however.

Statutory responsibility for the collection and disposal of solid waste within the Port Complex is presently divided between the City of Tacoma, Pierce County and the State Utilities and Transportation Commission, the Port having no direct role in the services provided by these jurisdictions. This situation places a major constraint on the Port's initiative for the unilateral development and implementation of the solid waste management

planning. However, proposed legislation should provide the Port with expanded responsibility in the field of environmental control, including solid waste management.

Three principal areas of investigation were identified for the conduct of the study: (1) solid waste management for the Port Complex, (2) solid waste management for terminal operations, and (3) demolition waste management.

B. SOLID WASTE MANAGEMENT FOR THE PORT COMPLEX

Sanitary landfill is the most feasible method for routine solid waste disposal for the Port Complex in the foreseeable future. Economic incentives do not exist at the present time to substantially increase the percentage of solid waste now being salvaged for reuse.

At current disposal rates, all local landfill sites in the Tacoma area are anticipated to be exhausted within 10 years. The acquisition and development of new sites are of critical importance.

The operation of new landfill sites remote from the local area will require joint operations by the City and County for major regional transfer stations to process waste from local collection trucks to the long-haul transportation vehicles.

The location of the Port and the available transportation networks make the Port especially well suited as the site for a regional transfer station. A transfer facility can be designed to meet environmental and aesthetic standards. A prototype of a modern, aesthetically pleasing railroad transfer station design is illustrated in Figure II-1.

The development of a transfer station at the Port Complex would provide the Port with a new tenant as well as a convenient location for the disposal of unconventional wastes (waste not amenable for pickup by conventional collection service).

An additional role identified for the Port involves the financing and construction of the transfer station facility for lease to the operating entity. This arrangement would be similar to arrangements made for existing terminal facilities leased by the Port.

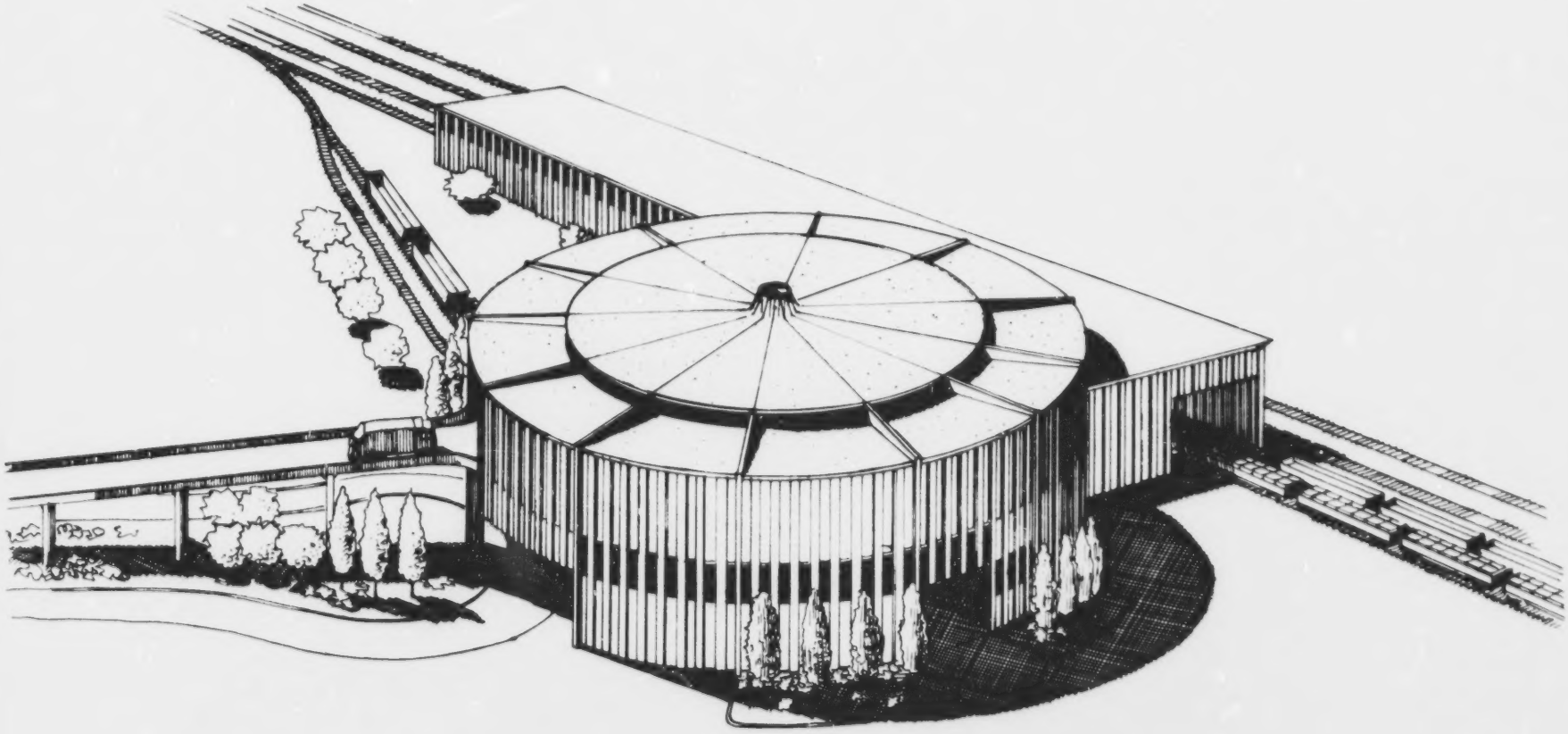

FIGURE II - 1

TRANSFER STATION

CIRCULAR CONCEPT FOR RAILROAD LONG-HAUL

A transfer station can be the first step in the development of a center for reclamation and recycling. It provides the flexibility for the addition of reclamation operations as they become technically and economically feasible.

A transfer station to serve the Tacoma area through the year 2000 is suggested to have an annual capacity of about 780,000 tons. If implemented by 1975, the estimated capital cost in 1975 dollars will be $1.2 million.

C. SOLID WASTE MANAGEMENT FOR TERMINAL OPERATIONS

Terminal operations account for about 4% of the solid waste generated in the Port Complex. Port sweeping crews are responsible for concentrating this waste for pickup by the City collection service. The Port crews appear to be quite effective in the performance of their solid waste management tasks. Collection of this waste by the City of Tacoma will continue to be the most feasible method for the disposal of routine solid waste from terminal operations.

When terminal operations are expanded to include Pier 7 and Pier 22, additional containers for pickup by the City collection service will be required.

D. DEMOLITION WASTE MANAGEMENT

Major quantities of future demolition waste are scheduled for 1975 (7,500 tons), 1980 (24,500 tons) and 1985 (16,300 tons). It is anticipated that demolition contracts will be awarded for this work in accordance with current Port practice.

The Puget Sound Air Pollution Control Agency (PSAPCA) has permitted the current disposal of demolition waste from Pier 22 by on-site incineration using an open-pit air-curtain incinerator. At the present time the open-pit air-curtain incinerator or a meteorologically scheduled open burn is the most feasible method available to the Port of Tacoma for the disposal of combustible materials from pier demolition, subject to obtaining a PSAPCA variance.*

Since a variance may not be allowed in the future, long-range planning at the County level must consider other alternatives for demolition waste disposal on an area-wide basis.

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*The Environmental Protection Agency does not agree with this recommendation since neither incineration method presently meets air pollution standards.

III. FINDINGS AND RECOMMENDATIONS

A. FINDINGS

1. Solid Waste Management for the Port Complex

a. Quantity

In 1970, excluding pier demolition waste, the Tacoma Port Complex generated about 80,000 tons of solid waste. Annual solid waste quantities for the years 1980 and 2000 are projected to be 139,000 tons and 234,000 tons respectively. The disposition of present and projected solid waste for the Port Complex (excluding pier demolition) is as follows:

	Solid Waste - Tons per Year		
	1970	1980	2000
To sanitary landfill disposal sites outside the Port area	35,000	100,000	166,000
On-site sanitary landfill disposal	21,000	-0-	-0-
Salvage	24,000	39,000	68,000
Total	80,000	139,000	234,000

A solid waste inventory for 1970 and solid waste projections for 1980 and 2000 are presented in the Appendix, Tables A-1 through A-3.

The Port is currently a major source of solid waste generated in the Tacoma area, and present and projected solid wastes from the Port are estimated at about one-third of the total amount of solid waste handled by the City of Tacoma. At present not all of the solid waste generated by the Port Complex goes to the Tacoma landfill site. About 21,000 tons

of waste, primarily from the mineral processing industries, are disposed of on site within the Port Complex, but this practice is anticipated to cease before 1980 because available space will be exhausted.

b. Characteristics

The wastes generated at the Port Complex are similar to solid waste generated in other industrial areas. Excluding pier demolition, principal components are minerals (37%), wood (31%), metals (18%), and paper (6%). Most of the solid waste from the Port Complex can be handled by conventional municipal waste handling equipment and disposed of in a sanitary landfill operation. Waste materials that can be handled by conventional equipment are defined as municipal wastes. Some industries generate large amounts of waste and find it more economical to haul these wastes to a disposal site. However, these wastes are still classified as municipal wastes if they can be handled by conventional collection equipment.

There are some special wastes at the Port Complex, but excluding the demolition waste, these constitute only about 4% of the solid waste generated. Chemicals, paints and petroleum comprise most of the special wastes. An allowance for condemned food which might result from Port Terminal operations has also been included. Disposal of this waste is subject to the control of public health officials.

c. Recycling

Approximately 30% of the solid waste material currently generated at the Port of Tacoma is salvaged for reuse. Most of the salvaged material is ferrous metal scrap (56%), selected wood waste (40%), and paper (3%).

There is little economic incentive at this time to substantially alter present practice. The technology for salvage and recycling has not been developed to the point where any specific new processes can be recommended for use in the Tacoma area. However, many new processes and concepts are under investigation, which, when coupled with the demand for and convertibility of raw material, will alter this condition in the future and significantly increase the amount of

material to be reclaimed or recycled. Many processes are being developed and demonstrated under the sponsorship of the EPA, and the results of this research will provide the basis for future solid waste management systems. Present planning must therefore have the flexibility to incorporate future developments as they become available. Since minerals, wood and wood products constitute the major portion of the Port's waste these are considered the most obvious components for expanded reclamation and recycling.

d. Jurisdiction

Under existing legislation the Port has no statutory responsibility for solid waste management. In fact, the Port's present responsibility is limited to: (1) gathering the solid waste generated by the Port itself (terminal operations) for subsequent collection and disposal by the City of Tacoma's Refuse Utility and (2) disposing of materials generated by the Port that the City cannot handle. The City of Tacoma, Pierce County, and the State Utility and Transportation Commission divide the responsibility for solid waste management. Recent legislation provides the Port with expanded responsibility in the field of environmental control including the authority to finance and construct environmental control facilities. This legislation may allow the Port to expand its responsibility in the area of solid waste management if the designated jurisdictions are not responsive to the needs and requirements of the Port and its tenants.

e. Planning

A master plan for areawide solid waste management in the Tacoma area does not currently exist. Pierce County has the statutory responsibility to develop a comprehensive master plan for solid waste management and has initiated such a study. This study, funded in part by the EPA, is scheduled for completion in 1972. As the major refuse utility in the area, the City of Tacoma will participate in the master planning program. The Port can participate in such master planning only on a cooperative basis with the City, County or

State Utility and Transportation Commission. This essentially precludes any unilateral planning activity by the Port, and an effective solid waste management system serving the Port and its tenants must interface with these jurisdictions.

f. Disposal Alternatives

Local disposal sites are rapidly reaching their capacity. At the present rate, the existing sites in Pierce County will be filled by about 1980. Methods for extending the life of existing landfill sites and the development of alternate sites were considered in this study, even though the final determination will be made by other jurisdictions. This investigation was included to identify the potential future role of the Port within the scope of areawide planning.

Three alternatives were considered for the disposal of municipal solid wastes for the Pierce County area: (1) incineration, (2) shredding (for compaction) and (3) long-haul to a distant disposal site. The objective of incineration and shredding is to prolong the life of landfill disposal sites.

In evaluating incineration, multichamber municipal incinerators with suitable air and water pollution control equipment could be designed to meet present environmental standards. Such a facility would be considerably more expensive in the Tacoma area than the other alternatives. Incremental revenue and costs associated with waste heat recovery or electrical power generation are marginal under the best of conditions. If considered, the residue from incineration will exhaust the Pierce County landfill sites prior to the year 2000. Although the evaluation of incineration is presented in this report, it is concluded that incineration is not a desirable alternative.

Shredding of refuse to improve compaction has been found to increase the longevity of sanitary landfills by about a factor of 2. The existing local landfill sites would be exhausted prior to the year 2000 even if shredding were used.

Since either incineration or shredding by themselves will exhaust the local disposal sites before the year 2000, a long-haul to a distant sanitary landfill site will be required. Thus,

a long-haul disposal system appears to be the alternative most likely to be adopted.

It is not feasible for the local collection trucks to carry the waste to a distant sanitary landfill site. Transfer stations are required to transfer the waste from the collection trucks to the long-haul vehicles. A transfer station must have surge capacity to hold the waste material prior to out-loading for transportation to the distant site. Transfer stations can also be designed with sufficient flexibility to incorporate salvage and recycling equipment when feasible systems become available. The flow diagram of a typical railroad long-haul disposal system shown in Figure III-1.

g. Long-Distance Haul Disposal - Port Participation

For the long-distance haul method, a major transfer facility is required to transfer the solid waste from the local collection trucks to the long-haul vehicles. Remote site(s) have not yet been located by the responsible agencies and therefore the mode of transportation (water, rail or highway) is still to be determined. Since the Port has an excellent road network for receiving incoming collection vehicles and can accommodate all three outgoing modes of transportation, it is well suited as a location for a solid waste transfer facility. The Port Complex is also the source of about one-third the total solid waste that would be handled by such a facility.

A transfer facility located within the Port's Industrial Development District can be designed to meet environmental and aesthetic standards and not depreciate the utility or value of adjacent property. The transfer facility should be located close to Interstate Highway 5 for the convenience of incoming traffic and to minimize collection vehicle traffic congestion in the Port area.

Approximately 10 acres of land should be allocated to allow for the future addition of facilities (when economically proven) to reclaim selected components (in addition to those currently reclaimed) from the solid waste stream. The receiving area for a recycling or salvage facility is similar to the receiving area of a transfer station. The transfer station is the first

FLOW DIAGRAM

LONG HAUL DISPOSAL USING CONTAINERS AND RAILROAD FLAT CARS

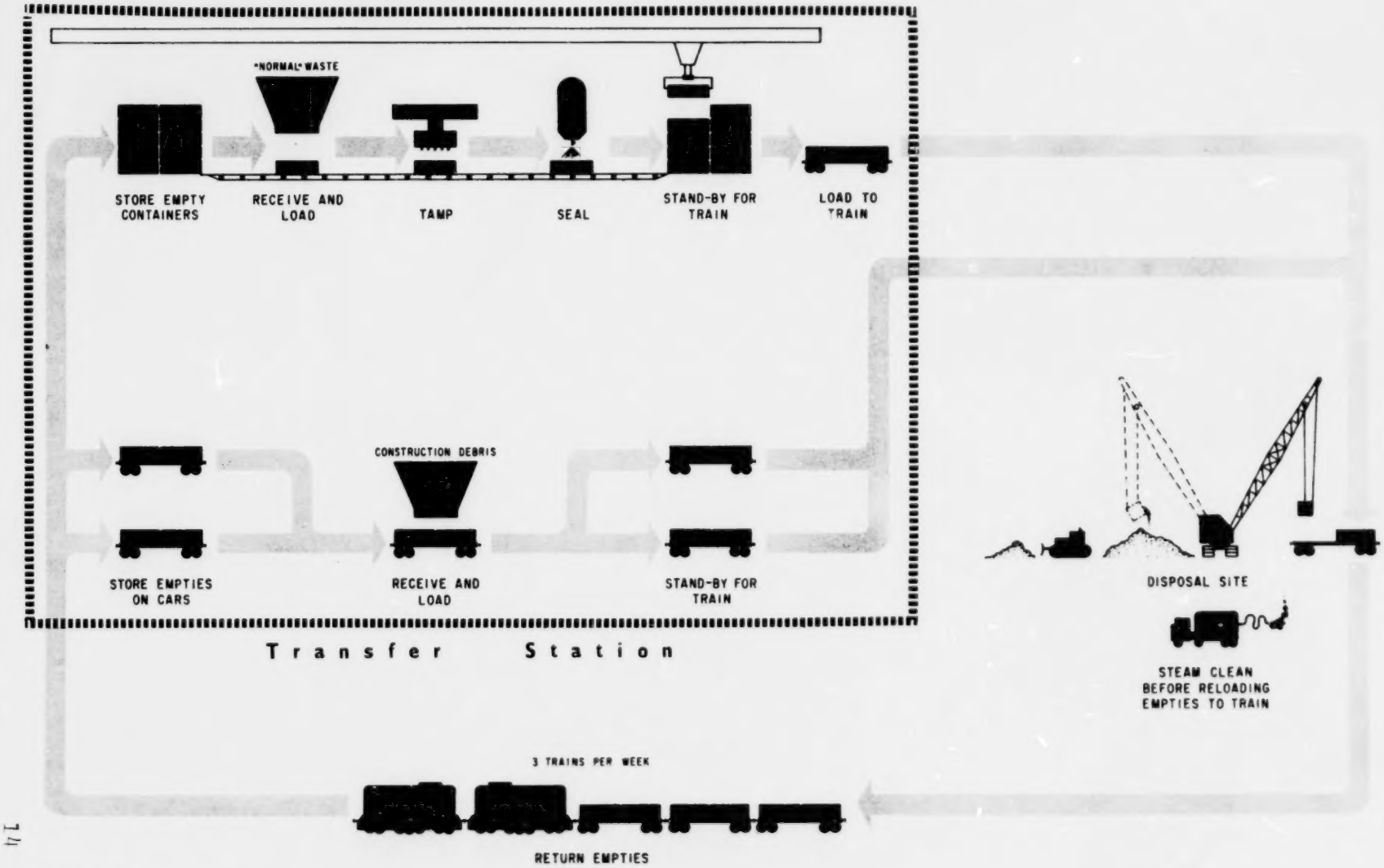


FIGURE III - 1

logical step in the establishment of a recycling plant. As recycling processes become available, they can be added to the facility, thus reducing the amount of waste sent to the distant landfill site.

An initial transfer facility with an ultimate annual capacity of 780,000 tons would serve regional needs to the year 2000. The estimated capital cost for such a transfer facility is $1.2 million (1975 dollars). The plan and cross section for one of several types of transfer stations is shown in Figure III-2. Typical arrangements for collection truck access for two types of transfer station design are shown in Figure III-3.

To restrict access to the site by the general public, thereby reducing vehicular traffic, satellite collection points could be included in the areawide master plan, or the City's existing landfill disposal site could be allocated to public use. Satellite collection facilities are not included in the above $1.2-million estimate. Another means of reducing light vehicular traffic to the transfer facility would be increased collection service utilizing special seasonal pickups to carry away such things as accumulated garden trimmings. Unless some means of reducing public access to the transfer facility is instituted, the peak vehicular traffic to the Port would be excessive.

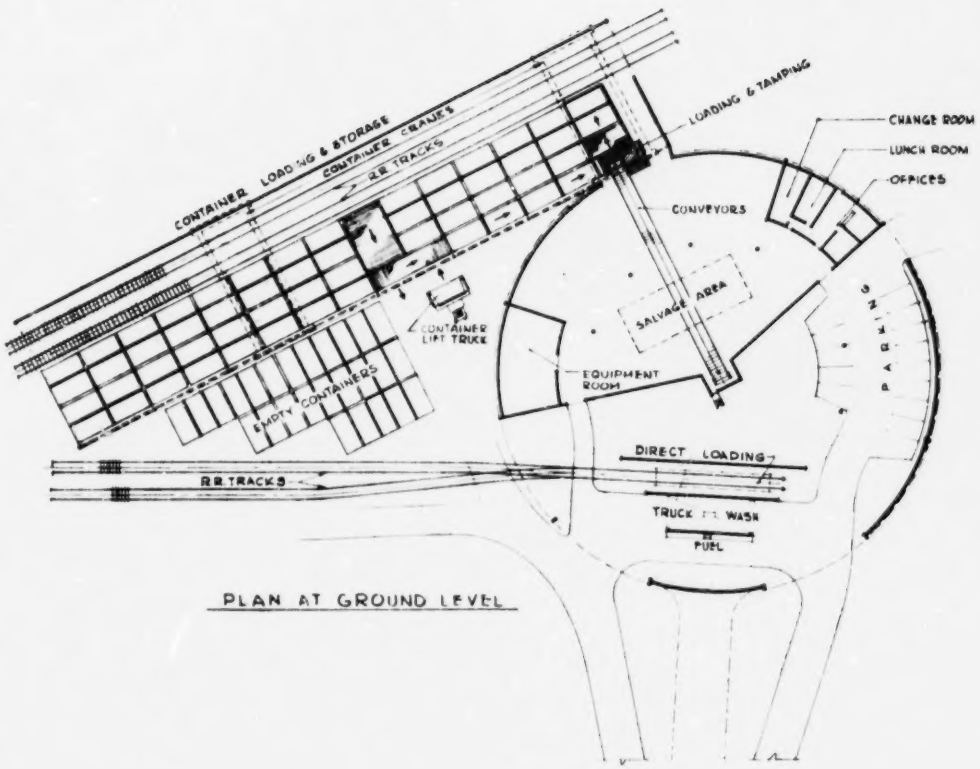
2. Solid Waste Management for Terminal Activities

a. Quantity

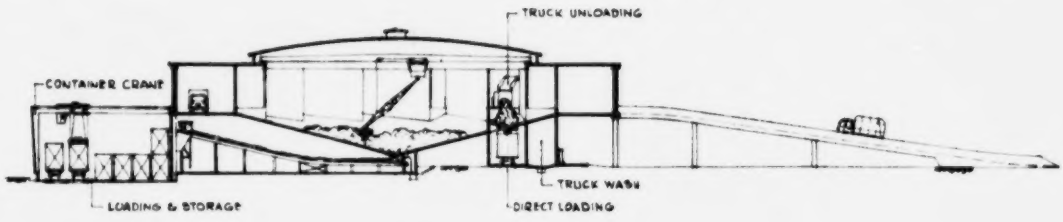
In 1970 terminal activities generated about 3,000 tons of solid waste excluding pier demolition. This is projected to increase to 9,000 tons by the year 2000. Terminal activities account for about 7% of the total solid waste generated within the Port Complex, excluding demolition waste.

b. Solid Waste Handling Practice

Sweeping crews are currently responsible for the gathering and concentrating of the dunnage, boxes, pallet boards, scantlings, paper and other solid waste generated by the shipping activities. The three-man crews are also responsible for general



PLAN AT GROUND LEVEL



CROSS SECTION

FIGURE III - 2

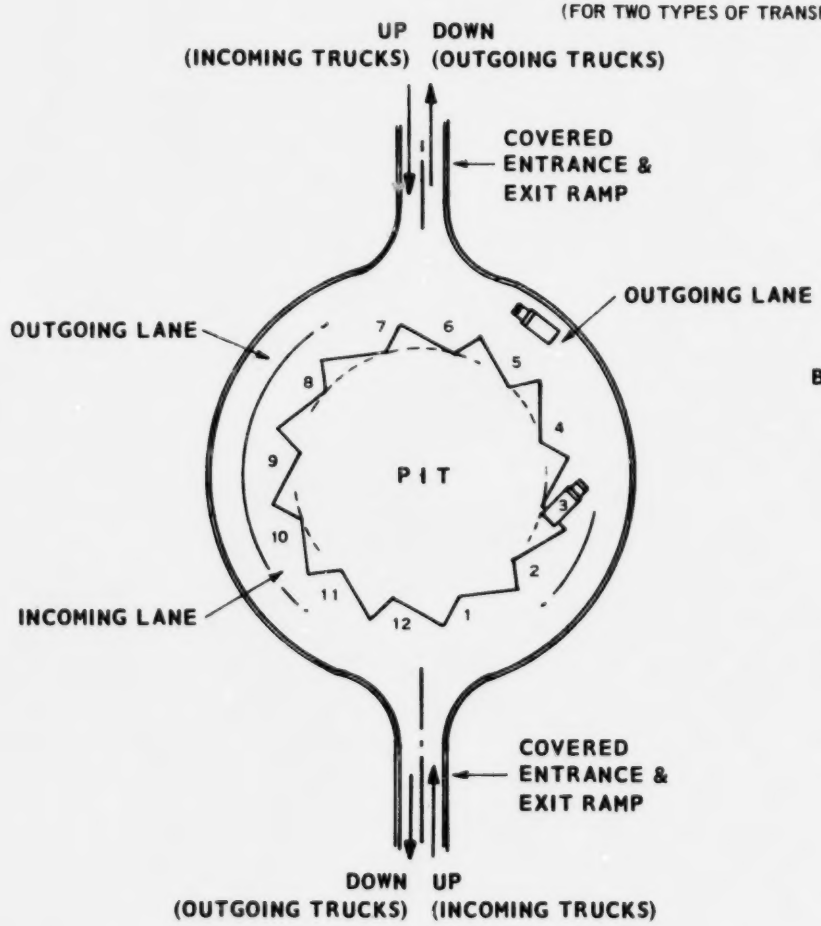
TYPICAL TRANSFER STATION

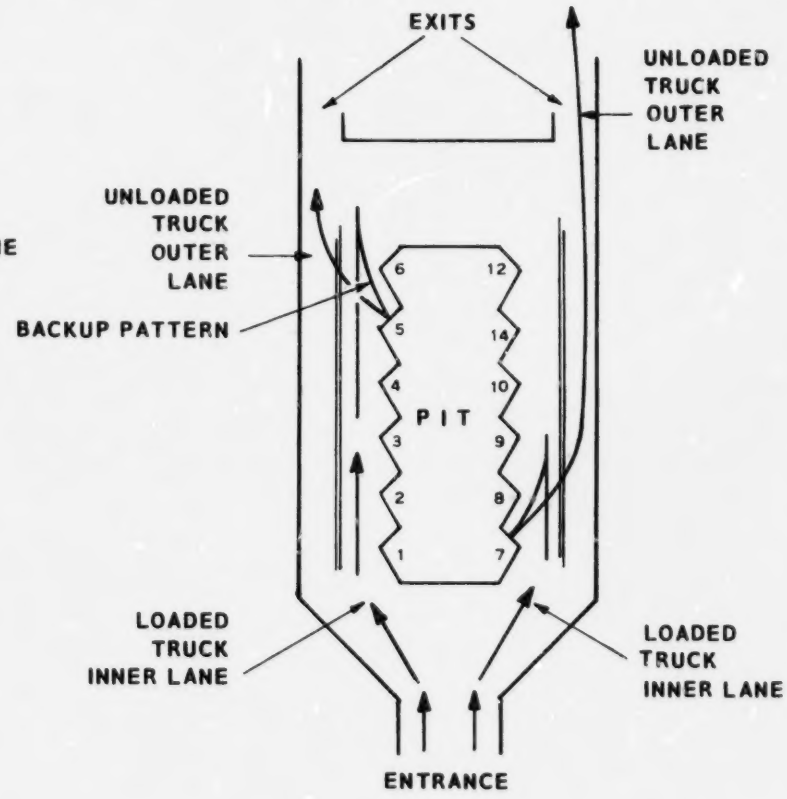
COLLECTOR TRUCK TO RAIL HAUL

Figure III - 3

TRANSFER STATION
TYPICAL ARRANGEMENTS FOR COLLECTOR TRUCK ACCESS

(FOR TWO TYPES OF TRANSFER STATION DESIGN)





FROM APWA SOLID WASTE RAIL-HAUL PROJECT

housekeeping maintenance in the Terminal Area and the Industrial Yard. The waste is deposited in a 25-cubic-yard bin for subsequent daily collection by the City of Tacoma's Refuse Utility. The net weight of the waste in this bin averaged about 3 tons per day (tpd) during a series of test weighings conducted in September 1971. Port lessees are responsible for solid waste disposal generated by their facilities, but they do look to the Port for guidance.

As Port activities increase, the amount of total waste will also increase. The re-establishment of terminal activities at Pier 22 and elsewhere in the Industrial Yard will also create a second source of waste from terminal operations located about 2 miles from present terminal activities. Other sources of cargo operation waste are as much as a mile from the centrally located 25-cubic-yard bin. This will present logistical problems in the future by concentrating all this waste in one central bin for subsequent pickup by the City's forces.

The average rate of 1,000 pounds of solid waste per man gathered daily by the six men of the sweeping crews is in accord with the productivity of other crews responsible for comparable tasks.

c. Solid Waste Collection

The present practice of solid waste pickup by the City satisfies the present requirements. The cost of this service is related to container size and/or frequency of pickup, and the cost for daily pickup of the existing 25-cubic-yard is $26 or about $700 a month. Provision for additional on-site storage and/or volume reduction equipment could affect container size and thus frequency of pickup. However, it is expected that the cost of such changes, particularly for volume reduction equipment, would more than offset any potential reduction in the present monthly collection fee.

Expanding port activity will necessitate additional set-out containers to be serviced by the City. The capacity and location of these containers must reflect the minimum total cost assigned to Port personnel and to the City pickup service.

d. Incineration

Open-pit incineration has been considered as a means for reducing the volume of solid waste generated at the Port prior to removal by City forces. Such incinerators do not meet current air pollution control emission standards and can only be operated with the expressed permission of the PSAPCA. While a variance may be obtained for special requirements (i. e., infrequent disposal of demolition waste), the open-pit incinerator is not considered acceptable as a routine method of waste disposal.

3. Demolition Waste Management

a. Quantity

Demolition waste quantities are identified with the Port modernization and expansion program. During 1971 the demolition of Pier 22 generated about 14, 400 tons of demolition waste. During the next 2 years (1973-74) there will be about 10, 800 tons of demolition waste. In 1975 there will be approximately 9, 600 tons. Additional quantities are projected for the years 1976 through 1978, 1980 and 1985. Wood comprises about 75% of the total demolition waste. About one-third of the wood waste is creosoted. The scheduled quantity of demolition waste and a breakdown by type (wood, concrete, steel and glass) is given in Table IV-2 (Schedule IV).

b. Characteristics

The demolition waste material consists principally of wood pilings and timbers from piers, and of wood from buildings in the Industrial Yard and the Terminal Area. The large size of individual pilings and timbers precludes their handling by conventional collection and disposal equipment and creates a major problem.

Concrete is another major type of demolition waste; however, the Port is able to reuse large pieces of this material as rip-rap for earthfill embankment protection within the Port area.

c. Burning

The continuous uncontrolled open burning of demolition waste was found unacceptable because of air pollution control considerations.

The bulk of the waste from the present demolition project on Pier 22 (14, 300 tons) has been burned in the contractor-built open-pit incinerator.

Performance evaluations made by other air pollution control agencies on similar equipment indicate that an open-pit incinerator cannot comply with the emission standards of the PSAPCA. Regulation No. 1 of PSAPCA does provide for variances which are applicable to the destruction of demolition waste. The continued use of the open-pit incinerator for destruction of demolition waste will be at the pleasure of the PSAPCA.

Emissions from the open-pit incinerator built and operated for the Pier 22 demolition project could be substantially reduced by changes in ignition procedure and by drying the wood prior to burning.

d. Disposal Alternatives

Six methods for the disposal of pier demolition waste were investigated:

(1) In-place use of pilings as falsework for new construction

(2) Open-pit air-curtain incineration and sanitary landfill

(3) Meterologically scheduled burn and sanitary landfill

(4) Sanitary landfill disposal

(5) Reduction in waste size by mechanical means and sanitary landfill

(6) Reclaiming or salvaging

The use of existing in-place piles as falsework for new construction is not considered practical by the Port of Tacoma because of pier configuration and anticipated construction techniques.

Since the bulk of pier demolition is wood waste, incineration is the most feasibile method of disposal. The open-pit incinerator has been discussed above. Considerable improvements in reducing the emissions could be achieved through better ignition and wood-drying procedures.

A meteorologically scheduled burn is a high-energy burn that destroys large amounts of dried demolition waste, that has been carefully stacked, on days when the wind will disperse the smoke rapidly and blow it away from urban areas. As much as 35,000 tons has been successfully destroyed in a single day by this method under variance in the San Francisco Air Pollution Control District.

The meteorologically scheduled burn has about the same total emission as a cleanly operated open-pit air-curtain incinerator and should similarly qualify for permission from the PSAPCA.

Also, the meteorologically scheduled burn is more economical than the open-pit incineration, and since the meteorologically scheduled burn destroys large amounts of waste only on days that air pollution will be light, there is less total air pollution impact on the community than with the open-pit air-curtain incinerator.

The alternative to incineration is sanitary landfill disposal and this may also require mechanical size reduction to transport the material and to effectively place it in the landfill. There are no readily accessible landfill sites which will currently accept large pieces of demolition waste, but the responsible jurisdictions are actively engaged in securing additional sites for this purpose.

Specially designed size-reduction equipment (shears and shredders) capable of handling large piles and timers are commercially available. However, the intermittent quantities generated at the Port and the limited duration of the demolition program would not fully utilize the capacity of such equipment and thus would not be an economically feasible solution for the

Port of Tacoma. An alternative would be a field fabricated machine similar to the "pile biters" used to shear pilings which could be used to reduce the large members to a manageable size.

The size and condition of the wood waste from pier demolition precludes any significant salvage value in the present market.

e. Demolition Contracts

The demolition contractor assumes responsibility for the method of disposal subject to applicable regulatory standards. However, it is to the Port's advantage to be able to suggest possible alternatives to the contractors which are environmentally sound and economically attractive.

B. RECOMMENDATIONS

1. Solid Waste Management for the Port Complex

a. Planning

We recommend that the Port immediately expand the close working relationship with appropriate City and County personnel for the purpose of developing a consolidated master plan which will include the Port Complex, the City of Tacoma and Pierce County.

b. Port-Located Transfer Station

We recommend the Port consider the location within the Port Complex of a major facility for the transfer of solid waste from local collection vehicles to the mode of long-haul transportation selected. The Port would gain a tenant with a potential use for marine and/or rail terminal facilities. The facility would also provide the Port and its tenants with a convenient location for the disposal of waste material not amenable for pickup by conventional collection vehicles.

The location would be environmentally acceptable since the transfer facility would be compatible with the industrial activity of the Port area.

We recommend that the Port consider the possibility of financing and constructing the transfer facility and leasing it to an operating entity. Currently proposed legislation would give the Port bonding authority to finance a transfer facility that would be of benefit to its tenants. Also the response time of the Port to financing such a facility would be quicker than the other agencies, particularly if the total service area included more than one county. The arrangement would be similar to that for existing terminal facilities presently leased by the Port.

The facility would be operated by the responsible governmental jurisdictions or their franchisees.

We recommend the Port take an active role in advising the neighboring communities and affected industries of the advantages associated with the location of a major transfer facility within the Port Complex.

The sooner such a facility is implemented together with the use of distant disposal sites, the sooner a greater capacity will be conserved at the existing local sanitary landfill sites for use when the distant sites are temporarily inaccessible due to natural disasters, transportation strikes, or similar causes.

c. Recycling

A periodic reassessment of the recycling potential for selected solid waste components generated by the Port and its tenants should be made as a part of the Port's long-term planning program. Provision for salvaging such materials can be incorporated in the proposed transfer facility.

2. Solid Waste Management for Terminal Activities

a. Solid Waste Collection

The Port should make greater use of City forces to collect solid waste from containers permanently located throughout the Port area as Port activities increase. This will decrease the need for expanding the sweeping crews by granting them more time to concentrate on their normal housekeeping activities.

We recommend the Port's sweeping crew activity be evaluated and that an analysis of the current budget be prepared to identify costs actually associated with solid waste management. This will provide the basis for evaluating internal collection procedures and the capacity and location of additional containers to be serviced by the City.

b. Open-Pit Incinerator

We do not recommend the use of the open-pit air-curtain incinerator as a routine method for disposal of combustible dunnage and pallet materials. This type of incinerator will not meet the environmental standards of the PSAPCA.

3. Demolition Waste Management

a. Burning

We recommend the use of the open-pit incinerator or a meteorologically scheduled burn as the more efficient and economical method presently available to the Port for the processing of combustible demolition waste. This recommendation is based on the fact that permission from the PSAPCA has allowed the use of open-pit incineration for the current demolition of Pier 22. Permission is granted at the discretion of the PSAPCA and future regulatory requirements may alter current policy.

b. Further Studies

We recommend that the Port undertake an investigative program to develop the techniques and procedures which will more economically utilize both the open-pit incinerator and the meteorologically scheduled burn and which will minimize the environmental impact on both the land and air resources. Local, state and federal agency participation in such a program should be sought since this investigation would have broader application than only at the Port. It should also be noted, however, that present EPA policy does not favor the meteorologically scheduled open burn.

c. Alternative Disposal

Sanitary landfill disposal is a preferred alternative to on-site incineration. We recommend that the Port work closely with planning jurisdictions to develop a sanitary landfill alternative for the disposal of future demolition wastes.

d. Demolition Contracts

We recommend that demolition and waste removal bids be solicited in such a manner as to include several optional alternative methods of disposal. The selected disposal method to be used by the successful bidder would be at the Port's discretion, subject to the pleasure of the PSAPCA and other environmental control agencies. This would permit the Port to retain the contingency fee normally included by the contractor in his bid to cover the most expensive disposal methods. If a variance is granted which permits the use of a less costly yet environmentally sound disposal method, then the Port need not spend its contingency fees. The selected contractor should be responsible for the obtaining of any variances and for disposing of the waste as stipulated by the terms of the variances.

The demolition contracts should provide sufficient time to allow for thorough drying of the wood prior to any burning activities.

IV. STUDY CRITERIA

A. INTRODUCTION

Prior to evaluating any solid waste management concept, it is necessary to establish a set of criteria which reflect the requirements of the area served. In this manner, the individual concepts are evaluated on a common basis. The criteria selected for this study reflect the policies of the Port and the appropriate governmental agencies, and identify the performance requirements of the facility and equipment. The policies presented herein are limited to those which would have influence on the Port's solid waste management requirements or on any solid waste processing facilities that may ultimately be located at the Port. Performance has two aspects. The first deals with the material handling capacities of a proposed facility, and the second deals with environmental control regulations and the aesthetic standards of the community.

B. SOLID WASTE MANAGEMENT POLICIES

1. Port of Tacoma Policy

The Port of Tacoma has an active interest in the continuous availability of a suitable solid waste management service for its terminal operations and for the tenants located within the Port Complex. The Port is not directly involved, nor does it intend to become involved, with solid waste management service activities.

This policy is altered only when the entities responsible for this service are not capable of handling a particular type of solid waste generated within the Port Complex. For example, the Port has contracted for the disposal of pier demolition waste by a demolition contractor, and it is expected that future pier demolition waste will be handled in a similar manner.

2. City of Tacoma

Within the City limits, the City collects all solid waste which is placed in standard containers, except for certain hazardous or objectionable substances. It is the City's sole right to collect and dispose of solid waste, but under special circumstances others may do so.

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Private citizens from within the Refuse Utility District are not charged for using the City's disposal site. Other individuals and commercial concerns are subject to a dump fee of about $2.50 per ton.

The anticipated life of the City's disposal site is less than 10 years. If no satisfactory alternative to sanitary landfill is available, the City anticipates hauling to a remote solid waste disposal site when the present site is filled.

3. Pierce County

The county offers no collection service, but is responsible for about 11 disposal sites. Private citizens are not charged for using these disposal sites. Presently there are 10 private collection companies serving Pierce County. These are licensed by the County and franchised by the State Utilities and Transportation Commission on an area basis. About five disposal sites within the County's jurisdiction have an anticipated life of 5 to 10 years, and the remaining disposal sites have an anticipated life of less than 5 years.

If no satisfactory alternative to sanitary landfill is available, the County anticipates that solid waste will be hauled to new remote landfill site(s) when present sites are filled.

Until recently there has been no overall coordinated solid waste planning by the County. This need has been recognized and through a resolution of concurrence by the elected officials, Pierce County has initiated a comprehensive solid waste management study with the assistance of the EPA Office of Solid Waste Management Programs.

C. SOLID WASTE MATERIAL HANDLING REQUIREMENTS

Solid waste management concepts are comprised of four basic components. These, including typical examples, are as follows:

- Storage systems--garbage cans, bins, stacked demolition waste
- Transportation systems--collection trucks, long-haul vehicles

- Disposal sites--sanitary landfills
- Processing facilities--transfer stations, shredders, recycling facilities, incinerators

Criteria are specified for each of the four components. The first three components are principally concerned with direct solid waste handling, and since the Port of Tacoma intends to remain free of this handling activity, the criteria for these components are covered briefly. The criteria for the processing facilities are developed in greater detail because the demolition and special solid waste problems associated with the Port are directly concerned with the processing and because a future regional solid waste processing facility could be located within the Port Complex.

1. Storage Systems

The storage systems criteria apply to the manner in which solid waste materials are stored at the point of origin prior to collection, at any processing facility, and at a disposal site prior to covering during the landfill operation.

Ordinances of the City of Tacoma specify the requirements for standard containers and containers of larger capacity require the approval of the City. In general, the criteria for all containers are that solid waste comprised partially or wholly of putrescibles must be stored in closed watertight containers and other materials must be stored in containers that will preclude any possible nuisance or hazard, e.g., blowing refuse. Material stored without containers, such as construction and demolition waste, must be protected for public health and safety and from fire hazard.

2. Transportation Systems

Solid waste material must be transported in vehicles that meet the criteria specified for storage containers.

3. Disposal Sites

Criteria for the capacity of sanitary landfill sites can be approximated. Presently, 15 acre-feet of disposal area per year is required for each 10,000 people served or 10,000 tons of solid

waste generated. Since a sanitary landfill includes about 20% of cover material, about 3 acre-feet or 4,900 cubic yards of suitable cover material per year must be available for each 10,000 persons served. Any new disposal sites serving the City and County are expected to be remote from the Tacoma area and will require a facility to transfer the solid waste from the local collection truck to the long-haul transportation vehicle.

The landfill disposal site must have geological features to preclude leachate from contaminating groundwater supplies, must have adequate drainage to minimize standing water, and must be located to prevent erosion of cover material by surface run-off or floods.

4. Processing Facilities

A processing facility must be able to handle the amount of solid waste generated within the region it is to serve. The facility must have adequate accessibility such that the collection vehicles can travel to and from the facility without creating a traffic problem or other nuisance. If required, the facility must have a suitable highway, rail or water connection to provide a means of hauling processed solid waste to the ultimate disposal or reclamation site. The facility must also provide adequate storage capacity to handle surges in incoming solid waste, outgoing solid waste and the salvaged materials. Additionally, the criteria for the process facility to handle any special wastes must be considered in order to best serve the particular needs of the region.

a. Waste Handling Capacity

The criteria established are based on the anticipated requirements to the year 2000. The current solid waste inventory and the current number of the vehicles that would require access to the facility were used as the basis for the projections for the years 1980 and 2000, and these projections are summarized in Table IV-1. The wood demolition waste from the Port is not included in Table IV-1, and is shown in the demolition schedule presented in Table IV-2.

The solid waste projections for the Port in Table IV-1 are based on the Port of Tacoma's plans for the expansion of Port facilities and services, and on the projected growth of the

TABLE IV-1

SOLID WASTE REQUIREMENTS AND VEHICULAR TRAFFIC[a]

Year	Port	Port, City of Tacoma and Adjacent Suburbs[b]	Pierce County
Tons per Year in			
1970	56,000	170,000	300,000
1980	101,000	290,000	460,000
2000	166,000	480,000	780,000
Collection Trucks per Day[c]			
1970	10	110	160
1980	20	170	230
2000	30	300	410
Commercial Vehicles per Day[d]			
1970	120	160	380
1980	250	270	570
2000	380	460	950
Private Vehicles per Day[e]			
1970	0	1,100	2,200
1980	0	1,600	3,100
2000	0	2,800	5,400

[a]Excludes demolition waste.

[b]Same general area presently served by the City of Tacoma landfill site.

[c]Based on 260 collection days per year.

[d]Based on 260 working days per year. Includes City and County loads other than collection trucks.

[e]Based on 120 weekend days and holidays per year.

TABLE IV-2

PORT OF TACOMA DEMOLITION WASTE SCHEDULE

Year	Area	DEMOLITION WASTE (Tons Per Year) Wood Creosoted	Wood Uncreosoted	Steel	Concrete	Glass
1971	Pier 22, Marina	3,200	11,100	150	-[b]	-
1972	Pacific Yacht Basin, Marina		40	-	40	-
1973	Industrial Yard		2,500	-	2,600	15
1974	Industrial Yard		2,600	-	3,100	10
1975	Industrial Yard Pier 25, Nichimen Log Area	1,300	6,100	230	2,000	10
1976	Industrial Yard		1,500	100	1,000	10
1977	Industrial Yard		2,200	40	2,100	20
1978	Industrial Yard, Tacoma Marina		3,200	-	4,800	20
1979[a]			-	-	-	-
1980	Pier 23 Pier 24 Pier 5 Kelley Farquhar Zidell Milwaukee Terminal Milwaukee Pier	7,500	17,000	140	9,470	20
1981-1984[a]						
1985	Pier 1 Pier 2 Hammerschmidt	13,800	10,000	240	1,100	10
Total		25,800	56,240	900	26,210	115

[a]Minimal Port Demolition Projects in 1979 and during 1981-1984.

[b]Dashes (-) indicate quantities less than 5 tpy.

Industrial Development District through 1980. Beyond 1980, a 3% average annual increase in solid waste generation has been assumed. Certain industries at the Port Complex are currently disposing of solid waste within their site boundaries; and for the purpose of establishing criteria, it is assumed that the disposal area available to these industries will be full by 1980. After 1980 all solid waste material will be disposed of outside the Port Complex.

Projections based on an estimated 3% annual increase in the solid waste generation in Tacoma and Pierce County have been used to approximate the solid waste load for the year 2000. The City and County projections are included to approximate the capacity of any regional processing facility that may be located within the Port Complex. For example, if the facility is to process waste material generated only at the Port of Tacoma, by the year 2000 the required capacity would be about 170,000 tpy. On the other hand, if a single facility located at the Port were to process all the solid waste generated in Pierce County, the estimated capacity for the year 2000 would be 780,000 tpy.

b. Vehicle Traffic

A facility serving all of Pierce County would receive about 1,360 (410 collection trucks and 950 commercial vehicles) vehicles per day for a 5-day workweek and about 5,400 private vehicles per day on the weekends and holidays. Several assumptions have been made in establishing the estimated number of vehicles. First, the present balance among private, commercial and collection vehicles will be maintained throughout the life of the facility and restrictions will not be imposed on the access of private vehicles. Second, the City's collection trucks were assumed to remain at the present average of 3 tons per load. Third, essentially all private vehicles will use the facility on weekends and holidays, although the number of private vehicles on peak days, such as at the height of the summer gardening season, could be double the estimated average value. Fourth, there are portions of the County that are not conveniently accessible to the Port area because of distance, but this reduction in vehicular volume will be offset by vehicles from communities near Tacoma in King County.

Since collection service is provided on some holidays, there will also be days when both the collection and private vehicles will be using the facility. If the average number of collection, commercial and private vehicles desired access on the same day, the assumption made in developing the criteria would indicate 6,800 vehicles in one 10-hour period by the year 2000. This obviously indicates the need for an alternative approach for the control of access by private vehicles, which can be accomplished by providing a series of satellite collection stations within the service area which would be served by regular collection trucks.

c. Special Wastes

There are several types of waste that require special consideration. One is demolition waste which was already mentioned. The Port is presently a major source; however, significant quantities are not anticipated beyond the year 1985 according to the schedule presented in Table IV-2. Demolition waste includes timber pilings of up to 2-1/2 feet in diameter and 70 feet long.

Other special wastes include small amounts of chemicals, paints, petroleum and condemned food which require special handling or equipment.

Conventional bulky solid waste from domestic sources includes furniture and appliances. Maximum size is assumed to be 3-1/2 by 6 by 8 feet, such as a large piece of furniture.

d. Salvage for Recycling

Portions of the solid waste sent to a processing facility may be reclaimed and ultimately recycled. The constituents of the solid waste materials generated within the Port Complex and estimated for the Tacoma area and Pierce County are given in Table IV-3. The difference between the total amount generated and the amount sent to the landfill site represents the amount salvaged at the Port Complex. Similar values are given for the entire County. For these estimates the City and County refuse is assumed to be similar to the residential solid waste composition averaged for 21 major US cities.

TABLE IV-3

SOLID WASTE SUMMARY
BY PERCENT OF TOTAL WASTE[a]

Category	Port Complex		Typical City[1]	Port, City and Adjacent Suburbs[c]	Pierce County
	Total	Landfill			
Wood[a, b]	31	86	11	20	16
Paper	6	7	45	34	37
Metal	18	2	9	7	8
Glass	1	1	9	7	8
Fiber, Plastic, Rubber	2	3	6	6	6
Minerals	37	54	4	10	8
Putrescibles	2	3	19	14	16
Special Wastes					
Chemicals	1	2	5	1	1
Paint and Petroleum	-[d]	1	5	-	-
Condemned Food	1	1	-	1	-
Hazardous Waste	-	-	-	-	-
Others	-	-	-	-	-
Total	100	100	100	100	100

[a] Demolition waste excluded.

[b] Includes garden waste.

[c] Same general area presently being served by Tacoma landfill site.

[d] Dashes (-) indicate amounts less than 1%.

[1] DeMarco, J., D. J. Keller, J. Leckman, and J. L. Newton. Municipal-scale incinerator design and operation. Formerly titled "Incinerator guidelines–1969." Public Health Service Publication No. 2012. Washington, U.S. Government Printing Office, 1969. 98 p.

D. ENVIRONMENTAL REGULATIONS

Federal, state and local laws recognize the need for and establish the authority to dispose of solid waste. These laws include the power to condemn land for use as sanitary landfills, correct public nuisances arising through improper refuse collection and disposal, and regulate industries with hazardous solid waste. The authority to certify refuse collection and disposal operations rests with the Washington Utility and Transportation Commission. Also, the State Legislature has given each county the responsibility for the solid waste planning for both short-term and long-term disposal facilities. Collection of solid wastes within the county's rural area as well as in cities and towns is becoming mandatory. This same legislation provides for cities, at their discretion, to develop their own comprehensive solid waste management program and submit it to the county for incorporation into an overall plan. The City of Tacoma is exercising this option. Most of the current legislation establishes the responsibility for solid waste collection. In the near future, it is anticipated that legislation will be enacted to establish the environmental regulations for total solid waste management. Listed below are the current and anticipated regulatory requirements.

1. Sanitary Landfill

All future disposal sites will be sanitary landfills. The criteria for the selection of sanitary landfill sites must include geological and soils engineering considerations to preclude leaching from the landfill into underground water supplies and to minimize settling. Covering of sanitary landfill (including compaction procedures) is required for odor control and for public health and aesthetic considerations.

2. Air Pollution

The Environmental Protection Agency has already established a regulation which limits the particulate emissions to less than 0.1 grain per cubic foot (reduced to 12% CO_2) for all new and substantially modified incinerators. This regulation virtually eliminates all single-chamber incinerators. The PSAPCA's Regulation No. 1 prohibits the emission of odors into the atmosphere. Also, any emissions which are detrimental to health or property are prohibited by this regulation. Future regulations may place

limits on other pollutants such as carbon monoxide and hydrocarbons. For example, the San Francisco Bay Area limits the emission of hydrocarbon and carbonyls to 25 ppm each.

3. Water Pollution

The sanitary landfill sites must be selected to preclude waste materials from entering into any water systems either during normal operations or as the result of surface run-off and flood conditions. In high rainfall areas, leachate collection and treatment may be required.

E. COST ESTIMATES

Capital and annual cost estimates for typical facilities have been prepared for purposes of comparison and evaluation. Certain assumptions have been made for the development of cost and financing requirements which reflect standard practice; however, it is recognized that the final cost structure must be in accord with the practices and procedures of the responsible entity.

Cost estimates for typical facilities have been based on published information obtained for similar facilities and on previous investigations conducted by Kaiser Engineers. Unless otherwise stated, overall costs were scaled by the 0.6 power law based on system capacity. The 0.6 power law reflects the economies attainable with larger capacities.[1] Building costs, such as those for transfer facilities, were assumed to vary with square footage, which is linearly proportional with capacity.

Neither a profit nor a fund for future expansion has been included in the chargeable costs. The annual capital costs are based on the assumption that funding will be through 6% bonds which will have the same life as the plant, namely 25 years, and therefore a capital return factor amounting to 7.8% of total investment is used to cover the interest payment and retire the bond's principal. Straight line depreciation has been assumed. Insurance is taken at 0.3% of the total investment. No taxes are paid by the facility. Therefore, the breakdown of annual capital costs is as follows:

[1] $\text{Cost}_1 = \text{Cost}_2 \, (\text{Capacity}_1 / \text{Capacity}_2)^{0.6}$

Component	Annual Percent of Investment
Depreciation	4.0
Insurance	0.3
Taxes	0.0
Cost of Capital	7.8
Total	12.1

An annual capital charge of 12% on the total investment cost is used. The chargeable costs are made up from the annual operating costs plus the annual capital costs.

The operating costs have been developed wherever possible using figures publicly available from various reports on existing or proposed facilities. Unless noted otherwise, the estimate of operating costs includes labor, supervision, benefits, utilities, power, fuel and maintenance. Also, the operating costs have, wherever possible, been estimated on a per-ton basis. Costs per unit volume are very difficult to compare because of wide variations in compaction densities.

Cost estimates have been presented in 1975 dollars, which is considered to be the earliest probable date for the construction of any major solid waste handling facilities in the study area. In order to obtain 1975 dollars, all costs were brought to 1971 dollars by application of two indices, the Engineering News-Record building cost index and the Marshall and Swift index for installed milling and mining equipment. Kaiser Engineers has found that the milling and mining equipment index is closely related to the costs of the shredders and crushers used in the mechanical size reduction of solid waste. For projecting from 1971 dollars to 1975 dollars, a 5% per year escalation (compounded) has been assumed. Thus, 1975 dollars are obtained by multiplying 1971 dollars by a factor of 1.22. The rate of 5% is about halfway between the last several years' experience and the currently anticipated rate sought by federal fiscal controls.

V. MANAGING ROUTINE SOLID WASTE GENERATED BY THE PORT AND ITS TENANTS

A. INTRODUCTION

Conceptual designs for technically feasible and aesthetically acceptable solid waste management systems are described in this section. The systems have been screened to present only those which show promise for solving the Port of Tacoma's solid waste problems and which can be integrated into a more comprehensive system serving a larger regional area. Preliminary cost estimates have been prepared for these systems. Current practices are described as background information and because they provide a feasible method of disposal as long as local landfill sites are available.

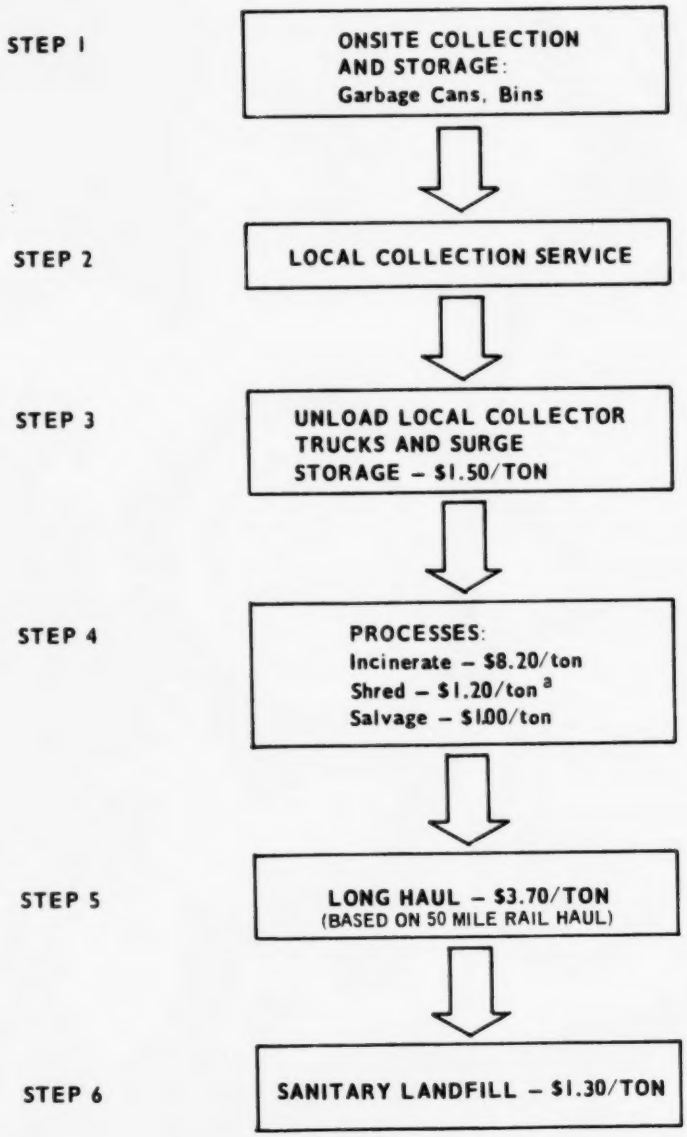
A total waste management system includes subsystems for storage, transportation, disposal and processing. In discussing conceptual designs for solid waste management systems, emphasis will be focused on those portions of the system that will serve the area through the year 2000. Figure V-1 identifies the successive steps of a generalized solid waste management system.

Referring to Figure V-1, the on-site collection and storage (Step 1) and the local collection service (Step 2) are common to all solid waste management systems. Step 1 is performed on the premises and the on-premises solid waste handling performed in support of the Port Terminal activities is discussed in Section VI. The local collection service will be performed by the City or contract haulers or, because of the quantity, may be self-hauled to local disposal sites. Unloading the collection vehicles (Step 3) may be combined with other steps and is most often included as part of the sanitary landfill operation (Step 6). In those situations where unloading the collection vehicles is not included with the landfill operation, the former is an activity common with most processing procedures (Step 4) or the preparation for long haul (Step 5). Processing may include any one of several volume-reduction and salvage operations. If the processing facility is not located at the landfill site, the long haul (Step 5) is necessary to carry the solid waste to the landfill.

Also included in Figure V-1 is the representative cost per ton associated with the various steps. Additional information on these costs is presented elsewhere in this section. The cost figures provide a

FIGURE V-1

SOLID WASTE – MANAGEMENT ACTIVITIES



[a] Does not include handling bulky waste. EPA - projected cost figures for shredding bulky waste are in the range of $6 to $12 per ton.

frame of reference with which to judge the relative cost of each activity. Since on-site collection and storage and the local collection service (Steps 1 and 2) are common to all systems, cost figures for these activities have not been included. The cost per ton for long haul and the sanitary landfill operation (Steps 5 and 6) are based on actual tons handled, and therefore the total cost would depend on the processing procedures (Step 4).

For example, the cost of disposing of municipal solid waste at the end of a 50-mile rail haul and using a shredder at the transfer facility can be estimated from the representative numbers in Figure V-1 as:

$1.50	Handling the waste through the transfer facility (Step 3)
$1.20	Processing the waste through a shredder (Step 4)
$3.70	Transporting the waste to the distant landfill site (Step 5)
$1.30	Disposing of the waste in a sanitary landfill (Step 6)
$7.70 per ton	

The conceptual designs of only the processing components are described in detail in this report. The components employed to accomplish on-site collection and storage, local collection and the sanitary landfill (Steps 1, 2 and 6) are assumed to be services provided by others and are further assumed to meet the criteria presented in Section IV. Thus further consideration of these three activities will be confined to the on-premises work performed by the Port. Since this study was completed prior to preparation of the Pierce County areawide plan, the presentation of the alternatives and the associated cost information is in a form that may be integrated with transportation and site selection studies performed by the City and County in developing an areawide plan for solid waste management.

B. PRESENT PRACTICE

The Port of Tacoma is presently dependent on City of Tacoma and Pierce County practices for the disposal of most of its solid waste.

1. City of Tacoma

The City of Tacoma (population 154,600) through its Public Works Department Utility Service Division, has been operating a Refuse Utility since 1929. This self-supporting utility charges reasonable service fees established by City ordinance. Revenue bonds may be sold to finance the Utility's capital improvements.

The Refuse Utility has the exclusive rights, with defined exceptions, to provide for the mandatory and universal collection, removal and disposal of garbage and refuse within the city limits. To provide these services, the Utility maintains a collection service and a disposal site. The Utility operates 26 rear-load packer trucks, each with a 20-cubic-yard capacity; one front-load packer truck with a 20-cubic-yard capacity; and four tractors for Dempster-Dumpster-type detachable containers. Conventional 32-gallon garbage cans account for most of the service, but the Utility also services over 1,000 containers ranging in size from 1 to 40 cubic yards.

The Refuse Utility operates a 200-acre disposal site located within the city limits. The site was purchased for $245,000 in 1964 with an anticipated 20-year life at the time of purchase. The sanitary landfill operation utilizes two crawler tractors (TD25 and TD20), a compactor-dozer, two scrapers (earthmovers), and a 2,000-gallon water truck. A new 800-hp shredder with a capacity of 50 tons per hour (tph) has been installed at the landfill site to process bulky items such as demolition wood waste, furniture and appliances.

Data on the operation of the City sanitary landfill site are presented in Table V-1.

TABLE V-1

SUMMARY OF
SOLID WASTE MATERIAL RECEIVED AT
CITY OF TACOMA SANITARY LANDFILL SITE
1970

Source		Number of Loads	Quantity of Waste (tons)
City			
	Collection Service	25,367	68,216
	Other City Departments	2,086	1,293
	Commercial	39,434	46,639
	Private Vehicles	124,468	21,770
County			
	Contract Collection Services	4,064	11,753
	Commercial	1,322	789
	Private Vehicles	9,164	2,138
Total		205,905	152,598

2. Pierce County

There are 18 incorporated areas in Pierce County. Tacoma and Puyallup (population 14,700) provide refuse collection and disposal services. Ruston (population 670) provides collection service, but uses the City of Tacoma disposal site. The balance of the County is served by 10 private companies and by individual citizens self-hauling their own refuse. The private companies use County disposal sites or the Tacoma or Puyallup sites. The major government installations, McChord AFB and Fort Lewis, maintain their own disposal sites.

Most of the County sites are open-face dumps, and with the cessation of burning at the dumps, the present sites are rapidly filling. Table V-2 is a description of the County disposal sites. In addition to the sites listed in Table V-2, there were over 800 known sites of illegal roadside dumping in Pierce County in 1970.

TABLE V-2

PIERCE COUNTY DISPOSAL SITES

Name	Size (Acres)	Type	Remaining Life (Years)
Anderson Island	10	Open-face, County-operated	5
Ashford	20	Open-face ravine, County-operated	5
Buckley	5	Open-face ravine, City-of-Buckley-operated	2
Carbonado	1	Open-face ravine, City-of-Carbonado-operated	1
Eatonville	5	Open-face ravine, City-of-Eatonville-operated	2
Elbe	4	Pit with cover, County-operated	0
Fox Island	2	Open-face ravine, County-operated	1
Key Center	2	Open-face ravine, County-operated	1
Orting	0	Open-face ravine, City-of-Orting-operated (weekends only)	0
Purdy	80	Open-face ravine with limited sanitary landfill, County-operated	7
Puyallup	0.5	Open-face ravine, City-of-Puyallup-operated	0.5
Roy	5	Open-face ravine, County-operated	5
Tacoma	200	Sanitary landfill, City-of-Tacoma-operated	9
Thun Field	35	Sanitary landfill, County-operated	5

3. Port of Tacoma

The Port of Tacoma is located partially within the Tacoma city limits. The portion within the City is serviced by Tacoma's Refuse Utility, and the balance of the Port area is serviced by private collectors. Additionally, certain activities within the Port Complex, both inside and outside the city limits, have contracts or self-haul arrangements to dispose of solid wastes not amenable to conventional solid waste collection and handling. The primary reason for use of the contract or self-haul arrangement is the large quantities of waste involved.

The solid waste generated within the Port Terminal Area is placed in conventional 32-gallon cans or bin-containers near their point of origin. Bulky materials are placed in a 25-cubic-yard container. The Port's sweeping crew collects the waste from the locally placed cans and bins along with debris from cargo-handling operation and deposits the waste in the 25-cubic-yard container which is picked up daily by the Refuse Utility. Used railroad ties from rail service maintenance in the Port area are stockpiled and removed by private citizens for landscaping or firewood use.

A substantial quantity of the solid waste material generated at the Port is currently being salvaged. Of the total of 80,000 tons of solid waste generated in 1970 by the Port and the industries located within the Port Complex, about 24,000 tons or 30% is estimated to be going to some sort of salvage or reclaim operation (Table V-3). The largest portion of the salvageable material is wood waste from the various lumber operations at the Port. The 30% salvaged represents the materials which can easily be segregated from other wastes and for which there is a ready market. Under present operating conditions, there is little economic incentive to segregate other wastes for their salvage value.

The disposal of demolition waste is a major solid waste disposal problem at the Port. A continuous open-burn is no longer acceptable because of excessive air pollution. Currently the waste is stockpiled for burning in an open-pit incinerator which has high-velocity jets supplying a blanket of over-fire air. This incinerator is similar to the DuPont Company design for destruction of potentially explosive chemical wastes, and for certain industrial waste material this type of incinerator has been estimated to have an emission of 0.25 grains per cubic foot[2] which is a dust-loading 2.5 times greater than current EPA emission standards for new or substantially modified incinerators. Data are not available on the dust loading from burning pier demolition waste in the open-pit incinerator. Special permission for the use of the open-pit incinerator is required from the PSAPCA.

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[2]Peskin, L.C. The development of open pit incinerators for solid waste disposal. Journal of the Air Pollution Control Association, 16(10):550-551, Oct. 1966.

TABLE V-3

SUMMARY OF SOLID WASTE DISPOSITION
AT THE PORT COMPLEX
(ton per year - 1970)

Waste Type	To City and County Disposal Sites		Disposal within the Port Area	Salvage	Total for Port Complex
	Collected by City	Collected by Others			
Demolition Waste, Wood	0	14,300	-	-	14,300
Wood	3,000	11,900	500	9,500	24,900
Paper	2,900	1,000	-	700	4,600
Metal	600	500	-	13,500	14,600
Glass	200	200	-	-	400
Fiber, Plastic, Rubber	700	800	-	-	1,500
Minerals	200	8,700	20,900	-	29,800
Putrescibles	500	1,000	-	-	1,500
Special Wastes					
Chemicals	-	1,200	-	-	1,200
Paints and Petroleum	-	300	-	-	300
Condemned Food	-	500	-	-	500
Other	-	-	-	300	300
Total	8,100	40,400	21,400	24,000	93,900

Note: 1. The dashes (-) indicate quantities of less than 50 tpy.

2. Summary includes estimates for solid waste generated by industries not responding to Port of Tacoma questionnaires.

C. ALTERNATIVE CONCEPTS

1. Introduction

Management systems for handling the solid waste routinely generated by the Port and its tenants are intimately linked with the City and County master plans for solid waste management. Therefore, to evaluate any system for the Port and its tenants, it is necessary to consider a tentative master plan which will be assumed similar in principle to the final plan adopted by the County. The following concepts were evaluated in detail:

- Incineration of municipal solid waste
- Shredding of municipal solid waste
- Long-haul disposal of municipal solid waste to distant landfill sites
- Salvage and recycling

From these evaluations, the long haul to distant landfill sites was the alternative that showed the most promise, and it is assumed to be the most likely solution for an areawide plan. It is also apparent that the Port could be the location for the transfer facility necessary to implement a long-haul system. It is further concluded that salvage and recycling methods have not been sufficiently demonstrated and proven for immediate consideration as a part of a solid waste transfer facility. However, the solid waste transfer facility can be designed and constructed with sufficient flexibility to incorporate future salvaging and recycling operations. While certain of these concepts show limited promise for the Tacoma area, they are discussed in this section to substantiate the conclusion.

A summary of the performance and the cost comparison for the various alternatives for processing municipal solid waste are shown in Tables V-4 and V-5.

2. Incineration of Municipal Solid Waste

For disposal of municipal solid waste, incineration may be used to accomplish volume reduction of the waste material, to provide waste heat or to prepare the waste material for a subsequent

TABLE V-4

PERFORMANCE OF ALTERNATIVE CONCEPTS FOR PROCESSING MUNICIPAL SOLID WASTE

Description of Alternative Concept	Increases In Disposal Site Longevity[a]	Safety and Environmental Regulations	Recycle or Salvage Potential	Aesthetic Factors
Incineration	2	Can be designed to meet Air Pollution Regulations	May facilitate salvage from residue	Tall chimney required
Shredder	2	--	Required as preparation for most salvage processes	--
Transfer Facility	--	Dust inside building can be controlled	--	Architectural treatment
Haul to Distant Disposal Site (50 miles by rail)	1	--	May enhance profitability of marginal salvage items by increase in volume of operation by serving larger region	--
Recycle Salvage	10	--	Paper, metal, glass	Tall chimney required

[a]Conventional sanitary landfill for similar unprocessed solid waste = 1.

TABLE V-5

COST COMPARISON OF MUNICIPAL SOLID WASTE MANAGEMENT CONCEPTS[a]

(Costs in 1975 dollars per ton of raw waste)

Cost Item	Alternative Concepts with Rated Capacities of 780,000 tpy							
	Direct Disposal		Shredding		Incineration		Salvage	
1. TRANSFER STATION								
Capital	0.13		0.13		Included in Item 2		Included in Item 2	
Operating	1.41		1.41					
		1.54		1.54				
2. PROCESSING								
Capital	-		0.02		1.72		2.21	
Operating	-		1.20		7.70		(0.21)[b]	
		None		1.22[c]		9.42		2.00[d]
3. TRANSPORTATION TO DISTANT LANDFILL SITE (50 miles)								
Capital	-		-		-		-	
Operating	3.45		3.45		0.86		0.43	
		3.45		3.45		0.86		0.43
4. LANDFILL SITE								
Capital	0.32		0.32		0.08		0.03	
Operating	1.00		1.00		0.25		0.10	
		1.32		1.32		0.33		0.13
TOTAL COST PER TON		$6.31		$7.53		$10.61		$2.56

[a] Local collection service not included.

[b] Profit from sale of salvaged materials. (See, W. Herbert, "The Franklin Environmental Control Complex: A Process for Recovery of Paper, Metals and Glass from Municipal Waste," in Journal of the Technical Association of Pulp and Paper Industry, vol 54, no. 10, Oct 1971)

[c] This does not provide for bulky materials. The cost of shredding bulky waste is projected by EPA at $8 to $12 per ton based on their St. Louis project.

[d] Basis: Black-Clawson Process (See, Herbert "The Franklin Environmental Control Complex..."). Current (1972) EPA projections for this process are $17 to $20 for a 50-tpd plant and $5 to $6 per ton for a 500-tpd plant.

reclamation process. Volume reduction by incineration extends the life of the sanitary landfill, and the waste heat may be used to produce salable steam or electricity, provided a market is available. Reclamation processes are being investigated that will salvage usable materials such as metals and glass from incinerator residue more readily than from raw refuse.

To obtain the most benefit from volume reduction, the combustion process must be complete, and combustible materials should not be found in the residue.

With complete incineration the life expectancy of a landfill site could be increased by a factor of about 11, provided the solid waste contains no bulky items.[3]

Certain bulky items such as heavy furniture, mattresses and tree stumps contain a high percentage of combustible material which does not have time to completely burn in most municipal incinerators. Without some form of pretreatment these materials are not suitable for incinerator feed. When the bulky items are sent directly to the sanitary landfill, incineration of the remaining solid waste will increase the life of the landfill site by about a factor of two over that of conventional sanitary landfill. This means that if an incinerator were installed to serve the Tacoma area by the year 1975, the then-remaining life expectancy of the City of Tacoma disposal site would be increased from 5 to 10 years. On this basis, a new landfill site would be required by 1985. Thus, incineration by itself would not meet the year 2000 criteria. A long-haul disposal system would still be required after 1985 for the incinerator residue as there are no known land parcels within Pierce County available for use as a sanitary landfill.

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[3]DeMarco, J., D. J. Keller, J. Leckman, and J. L. Newton. Municipal-scale incinerator design and operation. Formerly titled "Incinerator guidelines—1969." Public Health Service Publication No. 2012. Washington, U. S. Government Printing Office, 1969. 98 p.

The costs of a solid waste incinerator to satisfy projected needs for the year 2000 are estimated for various capacities as follows:

Service Area	Capacity Tons Per Day	Estimated Capital Cost Millions of Dollars-1975
Port of Tacoma only	650	$ 4.3
Port and City of Tacoma	1,850	$ 8.0
All of Pierce County	3,000	$11.2

The above cost estimates are based on an estimate prepared for an 800-tpd refractory-lined incinerator.[4] For this analysis the estimate was escalated to 1975 dollars and adjusted by the 0.6 power law for the various capacities (see Section IV).

Annual operating cost is estimated at $7.70 per ton. This cost is primarily labor, but an incinerator may also use up to 2,000 gallons of water per ton of raw waste. The estimated operating cost is based in part on a recent evaluation of 78 municipal installations of which 73% reported a cost of $5.00 per ton or less and four reported more than $10.00 per ton. Another source reported $5.00 per ton in 1968.[5]

For the Port study, $5.00 per ton was selected and escalated to 1975 to produce the $7.70-per-ton figure. Escalation was estimated at 5% compounded for 1968 through 1971 and at 8% compounded for 1972 through 1975, resulting in a factor of 1.54.

The chargeable cost for the incineration of solid waste in 1975 dollars is given in Table V-6. Annual capital cost was taken as 12% of total investment, and the operating costs at $7.70/ton.

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[4]Special studies for incinerators for the government of the District of Columbia, Department of Sanitary Engineering. Day & Zimmermann, Engineers and Architects. Public Health Service Publication No. 1748. Washington, U.S. Government Printing Office, 1968. 80 p. (Distributed by National Technical Information Service, as PB-187-286.)

[5]DeMarco, J., D.J. Keller, J. Leckman, and J.L. Newton. Municipal-scale incinerator design and operation. Formerly titled "Incinerator guidelines–1969." Public Health Service Publication No. 2012. Washington, U.S. Government Printing Office, 1969. 98 p.

TABLE V-6

ANNUAL COST OF INCINERATION (1975)

Chargeable Cost	Port Only 170,000 tpy	Port & City 480,000 tpy	Pierce County 780,000 tpy
Operating Cost	$1,310,000	$3,700,000	$6,000,000
Capital Cost	520,000	960,000	1,350,000
Total Chargeable Cost	$1,830,000	$4,660,000	$7,350,000
Chargeable Cost/Ton	$10.80	$9.75	$9.40

The recovery of waste heat from incineration for power generation or the production of salable steam does not appear feasible in the Tacoma area. Based on the incremental capital and operating costs of adding waste heat boilers and steam generators to the incinerator, the profitability of electricity generated by the incinerator would be marginal at best. In the Tacoma area, using conservative values of thermal efficiency and the heating value of raw solid waste, a loss of about $0.93/ton of raw refuse is calculated for power generated from waste-heat recovery. There is no known market for base-load steam at the Port. Therefore, utilization of waste heat has not been included as a recommended option for incineration.

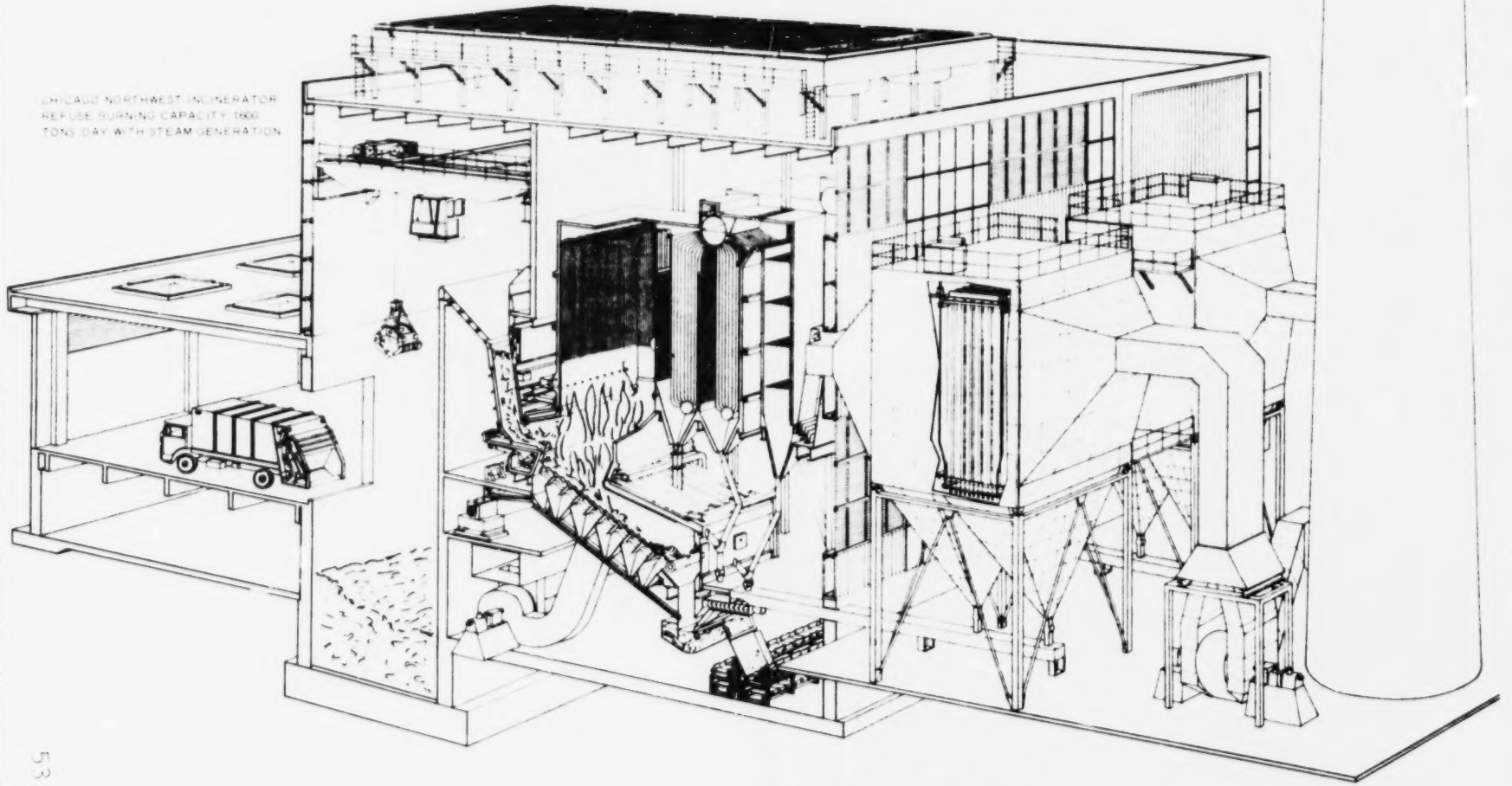
Since waste heat from incinerating has no ready market in the Tacoma area at the present time, the principal objective of incineration would be volume reduction of the solid waste to extend the life expectancy of a landfill site. With incineration, the life expectancy for a landfill site is increased by a factor of about 11, provided the solid waste contains no bulky items. However, this report further states that for all practical purposes, the life expectancy is only increased by a factor of about 2 when bulky items must be accepted at the disposal site. The factor of 2 would apply to the Tacoma area.

An illustration of a modern incinerator design and operating system is shown in Figure V-2.

Figure V - 2

TYPICAL MUNICIPAL INCINERATOR INSTALLATION

CHICAGO NORTHWEST INCINERATOR
REFUSE BURNING CAPACITY 1600
TONS DAY WITH STEAM GENERATION



3. Shredding of Municipal Solid Waste

Size reduction is desirable because it provides for a better utilization of available land at sanitary landfill sites. Size reduction is also a preliminary step in most reclamation processes. Several types of machinery are commonly used. For general use with municipal solid waste, hammer mills process domestic garbage and refuse, wood and metals. Chippers and shredders are used with the solid waste material which contain substantial amounts of wood and very small amounts of metals. Crushers are effective in reducing the size of brittle materials such as glass.

Size-reduction equipment represents a relatively lower capital cost and operating cost compared with incineration. A 40-tph hammer mill was selected as the basis for the development of cost estimates. The cost of this equipment was reported at $60,000 in 1970 and is escalated to $80,500 for 1975.[6] For the size of equipment needed to meet the municipal waste demands of the Tacoma area, the cost is about $1.00 per ton.[7] For 1975, this cost is escalated to $1.22 per ton. Included in the $1.22 figure is the annualized capital cost of the hammer mill, electrical motors and installation. The costs of land, site development and material handling equipment are not included. Based on the City of Madison's pilot plant study, EPA has reported cost projections for a complete shredder installation of similar capacity (315 tpd), including landfill disposal, at about $3.00 per ton. EPA projections for bulky waste shredding are considerably higher at $6.00 or more per ton.

The cost of a crusher varies much more nearly with the 0.8 power for different capacities, and this relationship is expected to be true for all size-reduction equipment.[8] The cost of size reduction equipment appears to be more dependent on the capacity and to a much lesser extent on the type.

A shredder must have a throat capacity to handle bulky items such as furniture, major appliances, water heaters, stumps and construction waste. These bulky items shorten the life of a landfill

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[6]Drobny, N. L., H. E. Hull, and R. F. Testin. Recovery and utilization of solid wastes; a summary of available cost and performance characteristics of unit processes and systems. Public Health Service Publication No. 1908. Washington, U. S. Government Printing Office, 1971. 118 p.

[7]Same as reference 6.

[8]Perry, J H., ed. Chemical engineers' handbook. 4th ed. New York, McGraw-Hill Book Co., 1963.

site appreciably unless they are processed into a form that will enable them to be compacted to nearly the same densities as the nonbulky solid waste. Unfortunately, most equipment suitable for general municipal use will not handle pier demolition waste without preprocessing.

Studies performed at Madison, Wisconsin indicate that shredded municipal waste can be compacted to about 1,200 pounds per cubic yard, while waste which is not shredded can be compacted to only about 900 pounds per cubic yard.[9] Therefore, a unit weight of shredded, compacted waste would occupy about 75% of the unshredded compacted volume. The following example illustrates the increase in useful life of a landfill site with shredding:

> In general 80% of the municipal waste is nonbulky material, and the remaining 20% is bulky material such as major appliances, furniture, mattresses, stumps and construction waste. Conventional sanitary landfill operation can achieve a size-reduction factor of 0.166 over the loose, uncompacted waste. Shredding improves that factor by another 75% resulting in a factor of 0.125. Bulky wastes are compacted by a factor of 0.5 in sanitary landfill operations. Shredding of bulky wastes reduces them to nonbulky wastes and the compaction or size-reduction factors for nonbulky wastes will apply.
>
> The size reduction factor at a sanitary landfill without shredding and with 80% conventional waste and 20% bulky waste is 0.233 (0.8 x 0.166 + 0.2 x 0.5 = 0.233). At a sanitary landfill site where only the nonbulky items are shredded, the reduction factor is 0.200 (0.8 x 0.75 x 0.166 + 0.2 x 0.5 = 0.200). At a sanitary landfill site where all the waste is shredded the factor is 0.125 (0.8 x 0.75 x 0.166 + 0.2 x 0.75 x 0.166 = 0.125).

From this example, there is little advantage in using the shredder unless bulky material is processed. This doubles the life expectancy of the landfill site over that expected from conventional operation. Unfortunately size-reduction equipment for municipal waste does not have the capacity to process pier demolition without additional preprocessing, and pier demolition waste is significant at the Port of Tacoma.

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[9]Reinhardt, J.J., and G. Rohlich. Solid waste reduction/salvage plant, City of Madison pilot plant demonstration project, interim report. U.S. Environmental Protection Agency, 1968. [26 p.]

4. Long-Haul Disposal to Landfill

A long-haul disposal system is required when the local collection trucks cannot economically transport the waste to a landfill site. Collection trucks then must take the waste to a transfer point where it is loaded on special trucks, trains or barges for shipment to the disposal site. There are two cost centers in the long-haul operation, the transfer station and the transportation.

a. Transfer Stations

The transfer station is common to most solid waste disposal processes. The transfer station consists of a tipping (dumping) area, a surge-storage pit, material handling equipment, plant building, heating and ventilating, utilities, roads and weigh scales. These costs have been estimated at about $1.8 million for a 5,000-tpd facility.[10]

Since the major components of the transfer station are the building, tipping floor and pit area, the station costs are about directly proportional to capacity. The size of the facility is nearly independent of the number of operating shifts because the local collection trucks must complete most of their work in one shift during the daylight hours. Therefore, the cost of the transfer facility is about the same whether it is feeding a 24-hour-per-day processing facility or is outloading long-haul vehicles which operate only 8 hours per day.

The estimated investment costs for a transfer station sized for different service areas are given in Table V-7. The capacity for each service area is based on solid waste projections to the year 2000, and costs are in 1975 dollars. The price of land at the Port is about $30,000 per acre, or about $10,000 per acre more than that assumed for other similar facilities.

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[10]The Western Pacific Railroad plan for disposal of San Francisco's solid waste. Kaiser Engineers, report no. 68-13-RE, Apr. 1968. [30 p.]

TABLE V-7
ESTIMATED COST OF TRANSFER STATIONS - 1975

	SERVICE AREA		
	Port Only	Port & City	Port, City & County
Design Capacity (tpy)	166,000	480,000	780,000
Daily Load @ 260 days per year (tons)	600	1,800	3,000
Estimated Capital Cost	$300,000	$750,000	$1,180,000
Annualized Capital Cost (12%)			
1980 Capacity ($/ton)	$0.35	$0.31	$0.31
Design Capacity ($/ton)	$0.22	$0.19	$0.18

The costs of access roads to the transfer station are not included. However, the Port's proximity to Interstate 5 enhances the accessibility to a transfer station serving the Tacoma region by collection trucks and privately owned vehicles. This convenient road access is suitable for vehicles hauling from the transfer station to a remote disposal site, and rail and water transportation is also available at the Port for this purpose.

The chargeable costs for operating a transfer station range from $1.00 to $1.50 per ton of refuse.[11] The lower value of $1.00 per ton of raw refuse in 1969 appears to be more appropriate, based on previous studies by Kaiser Engineers. Escalated to 1975, this cost is estimated at $1.54 per ton. This includes the annualized cost of capital.

The solid waste is accumulated at the transfer station. A pit provides surge storage and is sized in accordance with the operating

[11] Rail transport of solid wastes; a feasibility study; interim report, phase one. American Public Works Association Research Foundation. U.S. Department of Health, Education, and Welfare, 1969. 168 p. (Distributed by National Technical Information Service, as PB-187-306.)

characteristics of the rest of the system. If rail cars are to be loaded at the station, the pit must be large enough to store the solid waste delivered to the station until it can be loaded out. Similarly, if the station is part of an incinerator serving a power or steam generation system, the pit may have to store sufficient material to allow the plant to maintain service over an extended period when no collection trucks are arriving.

b. Recycling Systems

The transfer station can be used as the first stage of a recycling facility. The recycling facility requires the tipping area, the surge pit, the material handling equipment, the weigh scales and so on. As the recycling processes become available, the solid waste material can be moved from the surge pit to the processing equipment instead of directly to load-out. The material that is not salvaged can be passed to the load-out for the long haul to the distant disposal site, while salvaged material is shipped to its market. During any down-time for the recycling equipment, all of the waste can be diverted to distant disposal sites without having to be held for long periods in storage. As subsequently discussed (see Subsection V-C-5, "Salvage and Recycle"), there is currently no recycling process that can be recommended, and the transfer station will initially function to serve a long-haul disposal system. However, it is the logical first step in the development of a center for recycling.

c. Advantages

There are several advantages to having the transfer station within the Port Complex. A transfer station located at the Port would:

(1) Provide tenants of the Port with convenient access to a solid waste disposal system. The tenants who generate waste in such large quantities not amenable to conventional pickup would benefit most. Lime fines, rock wool and bark are typical wastes in this category.

(2) Provide the Port with another tenant.

(3) Provide the City of Tacoma with a transfer station located within a short distance of one-third of the solid waste generated in the Tacoma area.

(4) Be in an environmentally acceptable location, because of the present industrial nature of the Port.

(5) Provide the Port with a continuing source of revenue. The Port could undertake, on behalf of the appropriate jurisdictions, to finance and construct the transfer station for lease to an operating entity. This arrangement would be similar to existing terminal facilities leased by the Port. This may also simplify the financing if a number of governmental jurisdictions are involved, for example, if the service area were expanded beyond Pierce County.

(6) Increase the volume of existing salvage activity at the Port as well as create opportunities for new companies to engage in this activity, when the recycling systems are available for integration into the transfer station operation.

d. Cost of Rail Haul

The cost of the long haul is dependent on the location of the disposal site, however, the disposal site which will supersede the existing Tacoma sanitary landfill site has not been selected. With the site location unknown, the mode of transportation cannot be determined. For the purpose of this study it is assumed that the site will be within 50 miles of the Port and accessible by rail. The exact cost per ton would depend on the negotiated rate agreed to by the serving railroad, but a 50-mile haul is estimated to cost about $3.20 per ton. Since the average escalation for rail rates is generally less than for other items in the general economy, by 1975 the $3.20 per ton is expected to be about $3.45 per ton. This is based on an annual escalation of 2% compounded. However, if a train were dedicated exclusively to this service (unit train), this cost could be reduced by half.

The above cost estimates have assumed a weight-limited load. A weight-limited load means the vehicle transporting the solid waste will become overweight prior to exceeding its volumetric capacity. This assumption appears to be valid based on the recent transfer facility experience in San Francisco. However, the collection trucks in San Francisco are achieving about twice the compaction of those in Tacoma. Therefore, in order to achieve a weight-limiting compaction for the solid waste from

the Tacoma area, changes in collection procedures may be required. The most obvious change in procedure would be to load more material in the compactor trucks prior to going to the sanitary landfill site or a transfer facility.

5. Salvage and Recycle

A large fraction of the solid waste generated at the Port of Tacoma is already being recycled or salvaged. This is possible because the salvageable materials are being segregated at the source. It is believed that all marketable material that can be economically segregated at the source is now so processed. Any additional segregation of waste materials will have to be accomplished by separation at a central processing facility.

The key step for the salvage of material from the waste stream is the separation process. Hand picking and magnetic separation are the most common methods. New methods using screening, air classifiers and optical sorting are still in the developmental and demonstration stages. Their performance and costs are not yet adequately defined to permit an accurate engineering analysis. However, these new methods show promise, and within the foreseeable future some will be ready for full-scale application. Therefore, the design of any facility must provide the space and flexibility to incorporate these separation operations when they become feasible.

Hand-picking is still widely practiced but is generally limited to the recovery of a few selected items. The method is unsatisfactory for large-scale operations because of labor cost and limitations on the size and type of material that can be recovered.

a. Metal Salvage

Magnetic separation has proven to be an effective means of salvaging ferrous metal materials from the waste stream. An estimated 13,000 tons of metal are recovered from the 14,000 tons of metal generated annually within the Port Complex. The 13,000 tpy would represent the waste metal that is high-quality scrap with attractive resale value. The remaining 1,000 tpy are not all ferrous metal and the economics of salvaging the remaining ferrous materials from the Port waste will be marginal. However, since the solid waste from the City will be commingled

with the Port's waste at a processing facility or a transfer station, magnetic separation could be used to extract the ferrous metals from the present estimated 21,000 tpy of metal wastes from the Port, City and County. A market for such ferrous scrap is available through a Port tenant presently engaged in the metal salvage business.

b. Wood Salvage

About 38% of the wood waste from the Port Complex is being salvaged. This percentage does not include demolition wastes. Most salvaged wood is sawdust and is processed into a form that can be sold as fuel. Wood waste consisting mainly of bark and slash from log handling activities contains dirt and other tramp materials and greatly reduces the market value of this wood waste. At the present time the wood waste that has economic value is already being salvaged. In the Tacoma area, like most lumber-producing areas, the price of virgin wood is variable from season to season and year to year, and the salvage or recycle value of wood waste or wood products will vary accordingly. However, the future market for these salvaged materials appears favorable in that the wood products industry is striving to eliminate all waste wood by absorbing it in the industry operations.

c. Recycling Systems

Several process systems are currently going through development and demonstration phases. One system, the Black-Clawson demonstration facility at Franklin, Ohio, may have future application in the Tacoma area (see Figure V-3). The Black-Clawson concept relies heavily on the technology developed for the pulp industry, and one of the principal reclaimed materials by the process is paper pulp.

The facility installed at Franklin, Ohio (population 12,000) also includes industrial and municipal wastewater treatment. The amount of land required for this facility is about the same as for a wastewater treatment plant serving the same population. A facility for the Port of Tacoma would require about 10 to 15 acres.

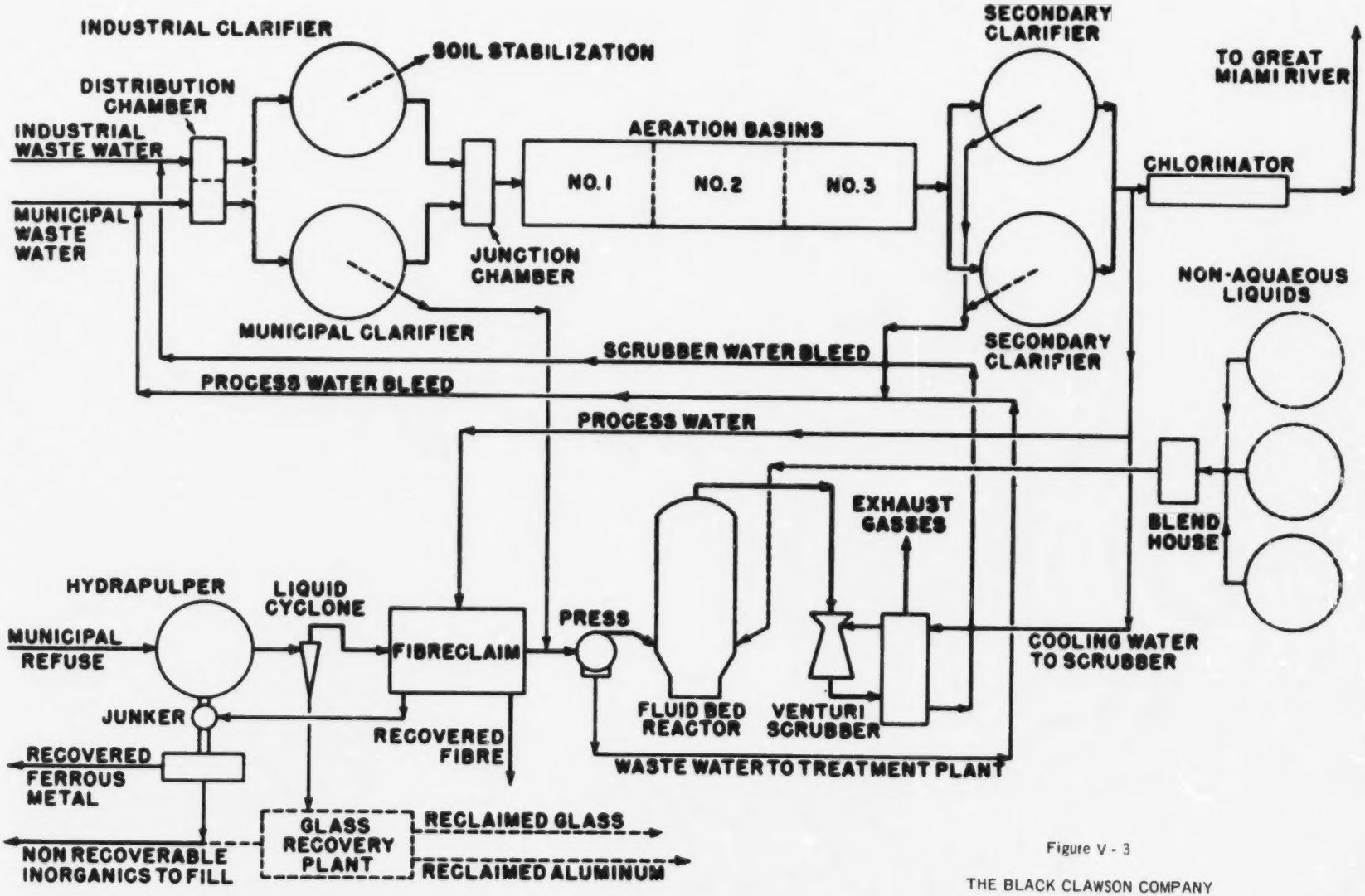

Figure V - 3

THE BLACK CLAWSON COMPANY

FRANKLIN ENVIRONMENTAL CONTROL COMPLEX

The Franklin, Ohio facility has been in operation since June 1971. Although early cost estimates were projected at about $2.00 per ton (see Table V-5), current projections by EPA on the basis of limited operating experience are $17 to $20 per ton for a 50-tpd plant and $5 to $6 per ton for a 500-tpd plant. These estimates include operation and amortization.

d. Other Processes

Other processes for salvage and recycling that are in the conceptual development pilot plant or demonstration stage include composting, pyrolysis and the beneficiation of incinerator residues.

- Composting

Composting is an aerobic biological decomposition process for the breakdown of solid organic material under controlled conditions. The objective of composting is to convert the organic matter in refuse to a nuisance-free, humus-like end product which can be used as a soil conditioner or a fertilizer base.

At present a large-scale market for the compost product is nonexistent, the reason being that the cost of producing compost, and the costs of hauling and spreading this material are prohibitive in comparison with those for synthetic chemical fertilizers. Compost cannot compete with the chemical fertilizers in terms of its fertilizer value. It is a good quality soil conditioner, but farmers have quantities of soil conditioners available in the form of manure and plant trimmings. Composting reduces the volume of the raw waste by about 50%. Thus with the poor market for compost and the remaining disposal problem, the compost process has failed to demonstrate any strong advantages.

- Pyrolysis

Pyrolysis (destructive distillation) is a process which produces a chemical change in materials exposed to high temperature (800 to 1500F) in an oxygen-free atmosphere. The objective is the thermal reduction and hence partial decomposition of organic materials to relatively simple intermediate

compounds. Applied to municipal solid waste, products include tar and pitch, light oil, ammonium sulfate, char residue and gas. Research on solid waste applications has been conducted by the Bureau of Mines[12] and West Virginia University.[13]

- Beneficiation of Municipal Incinerator Residues

A 1/2-tpy pilot plant for the physical beneficiation of municipal incinerator residues has been operated by the Bureau of Mines at the Metallurgy Research Center, College Park, Maryland. Products include ferrous and nonferrous metals, glass, sands and residues containing carbonaceous materials and various minerals. Based on this research, the beneficiation cost for a large-scale plant has been estimated (1969) in the range of $2 to $4 per ton of incinerator residue (excluding amortization), depending on plant capacity.

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[12]Sanner, W.S., C. Ortuglio, J.G. Walters, and D.E. Wolfam. Conversion of municipal and industrial refuse into useful materials by pyrolysis. U.S. Bureau of Mines, Report of Investigation No. 7428. Aug. 1970.

[13]Solid waste: a new natural resource. West Virginia University, Dept. of Chemical Engineering, May 1971. 16 p.

VI. HANDLING SOLID WASTES GENERATED FROM PORT TERMINAL ACTIVITIES

A. INTRODUCTION

Under present statutory regulations, the Port of Tacoma is excluded from any solid waste handling functions except those conducted on its own premises and the disposal of solid wastes not amenable for handling by the City of Tacoma and by Pierce County collection contractors. Some solid wastes generated in the Port Terminal area are the responsibility of others. The solid waste generated aboard ship is the responsibility of the shipping company representative. While the Port has no direct responsibility in these areas, the Port is looked to for guidance in solid waste handling.

B. PRESENT PRACTICE

The Port carries out its own housekeeping activities with two three-man crews, a sweeping machine, a front-end loader, and a dump truck. In the near future, it is planned to replace the existing sweeping machine with two new machines. The sweeping crews are responsible for both general housekeeping and some light maintenance as well as solid waste handling. The total labor budget for these crews is about $63,000 per year. The percentage of this budget allocated to solid waste handling is not separated from the other functions.

During cargo handling operations, dunnage, wood scantling, broken pallets, crates, boxes and waste paper are left in the terminal area by the longshoremen. The maintenance crews are responsible for gathering these wastes and placing them in a centrally located 25-cubic-yard bin. This bin is collected daily by the City of Tacoma for disposal at the City's sanitary landfill site. A series of test weighings conducted at the Port in September 1971 showed the net weight of this bin to average about 3 tpd. Each member of the sweeping crew is thus collecting about 1,000 pounds of solid waste daily. This figure is approximately double the amount of waste material collected by street sweeping crews in major metropolitan areas where the sweeping crews also have responsibility for the collection of litter cans. On a comparative basis, the Port's crews are quite effective in their solid waste management tasks, especially considering their other housekeeping and maintenance responsibilities. The productivity of a solid waste collection crew working under

assembly line conditions in an industrial plant would be about twice that of the Port's sweeping crew. However, such conditions are not comparable to those at the Port.

The cost to the Port for the daily collection of the 25-cubic-yard bin is approximately $7,000 annually. Since the charges by the City are based on a volumetric rate, volume reduction by a factor of 2 would result in a savings of about $3,500 annually. However, it is estimated that the cost of volume-reduction equipment would more than offset the potential savings.

It has been suggested that an open-pit air-curtain incinerator be considered to reduce the volume of the solid waste generated by terminal activities. Although such incineration will provide an appreciable reduction in combustible solid waste volume, this type of incinerator will not meet the air pollution control standards of the PSAPCA. This type of incinerator is discussed further in Section VII.

C. ALTERNATIVE CONCEPTS

Currently there is no viable alternative to the solid waste handling practices at the Port, with a few minor exceptions. The containers which are permanently assigned to specific areas, such as at the marina and at the cold-storage facilities, could be serviced by the City of Tacoma directly, eliminating the need for the Port's crew to provide the intermediate handling. With the initiation of shipping activities at Pier 22 in the industrial yard, a centrally located bin will be required in this area. This would eliminate the 4-mile round trip from Pier 22 to the existing bin on Pier 2. A collection bin can also be placed in the Pier 7 area, eliminating the 1-1/2 to 2-mile round trip to the bin presently located at Pier 2. Direct savings are not anticipated to accrue as a result of the location of these bins, but there will be a savings in manhours. Initiation of these steps is not required until such time as expanding terminal activities place a greater burden on the present sweeping crews.

VII. MANAGING DEMOLITION WASTE

A. INTRODUCTION

The current program at the Port of Tacoma for the renovation and expansion of terminal facilities is creating large amounts of demolition waste. Wood from old pier demolition is the primary waste constituent.

The major problem associated with the disposal of the Port's demolition waste is its size. Pier pilings may be as much as 2-1/2 feet in diameter and 70 feet long. Pier planking and timbers may be up to 30 feet long. These timbers are difficult to transport and to handle in a sanitary landfill operation. Unless carefully placed at a landfill site, the configuration of the long timbers may be similar to that found in a game of pick up sticks. Because of the size of this waste, most compaction equipment cannot conveniently rearrange the stack to a denser configuration. Conventional sanitary landfill equipment is not heavy enough to break the wooden members of the stack for effective compaction in the landfill.

Demolition waste is acceptable at a sanitary landfill site provided it is small enough to be easily handled and can be compacted by conventional equipment. The City of Tacoma disposal site will not accept demolition waste larger than 1 foot in diameter and 12 feet in length. Waste from building demolition projects at the Port is not a major problem because the members are smaller and more easily broken up than the waste from pier demolition projects. This section is therefore directed primarily to pier demolition waste and other demolition waste with large-size components.

Although the local landfill sites in the vicinity of the Port of Tacoma will not accept the pier demolition waste, the City of Tacoma, which has jurisdiction, is actively seeking a new sanitary landfill site that will have the capacity to accept this waste. To date no new sites have been opened.

B. MANAGEMENT ALTERNATIVES

1. Salvage

Portions of the pier may have an in-place salvage value depending on design and construction of the new concrete piers. The

existing pilings may be usable to support the false-work during the construction of the new pier, depending on the construction procedure selected. The new pier configuration and construction techniques anticipated at the Port appear to preclude this alternative.

Experience with the disposal of used railroad ties has shown that local citizens will carry off this waste at a rate which is sufficient to eliminate a disposal problem. The possibility that portions of the demolition waste could be similarly disposed of should be considered. However, the annual demand by the citizens would have to be about 300 pounds per capita for the 150,000 people in Tacoma to carry off the 14,000 tons of demolition waste generated in 1971. This utilization rate is highly unlikely. Demolition waste would also be an attractive nuisance, and this would imply some responsibility on the part of the Port if the public was encouraged to participate.

2. Processing

The nature of this wood waste makes it difficult to reduce the size by conventional methods. Many of the pilings are heavily loaded with preservatives which would make manual operations, such as chain sawing, very difficult. The use of wood chippers or hogs would experience high maintenance costs due to blade damage resulting from striking tramp metal components in the wood such as bolts, spikes, drift pins and other connecting devices.

Two feasible methods for size reduction are combustion and mechanical processing. Combustion reduces the size of the individual members as well as reducing the total mass of the waste. Mechanical methods reduce the size of the individual members by cutting, shearing, splitting or shredding. Mechanical methods provide no overall reduction in the mass of the material which must go to the landfill site. A comparison of the performance and the cost of these size reduction methods is given in Tables VII-1 and VII-2.

C. COMBUSTION OF DEMOLITION WASTE

1. Continuous Open Burn

The simplest method for reducing the size of demolition waste is through a continuous open burn. The waste is stacked as it is

TABLE VII-1

DEMOLITION WASTE

PERFORMANCE OF ALTERNATIVE CONCEPTS

Alternative Concept	Disposal Site Longevity Factor[a]	Safety and Environmental Regulations	Recycle or Salvage Potentials	Aesthetic Factors
Open Pit Incinerator	15	Air pollution permit or variance required	None, except steel fasteners from piers	Continuous smoke
Massive Open Burn	30	Air pollution variance and Fire Marshal approval required	None, except steel fasteners from piers	Intermittent smoke
Sawing	-[b]	Operator safeguards required	Some salvage by public	Noise
Shearing and Splitting	3	Operator safeguards required	-	-

[a]Sanitary landfill longevity for similar unprocessed waste assumed as a factor of 1.0

[b]Process not adequate for sanitary landfill disposal

TABLE VII-2

DEMOLITION WASTE

COST COMPARISON FOR ALTERNATIVE CONCEPTS (1975)

Alternative Concept	Capital Investment	Chargeable Costs Per Ton			Total Cost to Landfill Per Ton of Demolition
		Capital	Operating	Total	
Open-Pit Incinerator	$15,000	$0.25	$1.75	$2.00	$2.62
Massive Open Burn	None	None	$0.20	$0.20	$0.82
Sawing	None	None	$0.60	$0.60	-[a]
Shearing and Splitting	$23,000	$0.38	$1.50	$1.88	$8.19

[a]Further processing required prior to disposal

taken from the demolition area and fired. The result is a continuous low-temperature burn which consumes the demolition waste as it is generated. This type of burn produces smoke since the relatively low operating temperature will volatize portions of the wood and the preservatives without actually burning the volatiles which condense to form smoke. The large quantities of ash also contribute to the smoke and haze from the fire.

The continuous open burn has been attempted at the Port of Tacoma and been found unsatisfactory from an air pollution standpoint. Furthermore the residue from the continuous open burn may be 50% of the original mass, and would result in some of the residual material being of an unacceptable size for disposal at the City of Tacoma's sanitary landfill site.

The continuous open burn is unacceptable from an air pollution and size reduction standpoint.

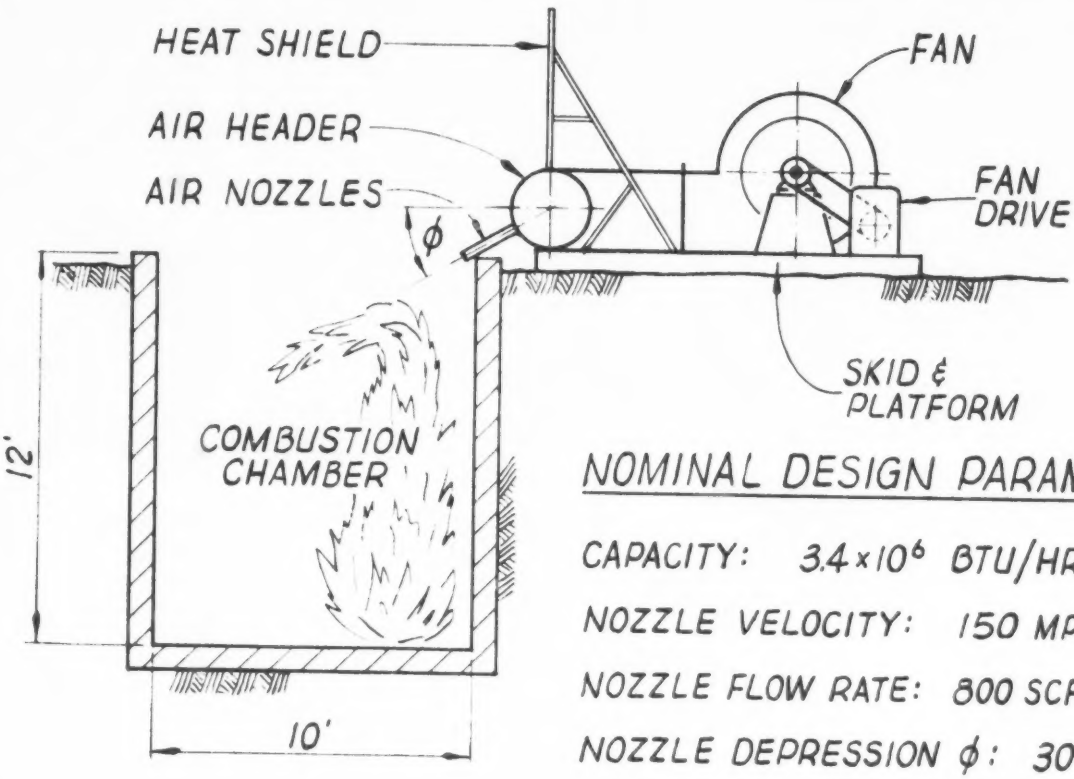
2. Open-Pit Air-Curtain Incinerators

The operational procedures require a crane or fork lift to load the heavy demolition waste into the open-pit incinerator. The incinerator can be operated on a continuous basis. Most of the 14,000 tons of wood waste for the Pier 22 demolition project has been processed in an open-pit incinerator built by the contractor specifically for that purpose.

An open-pit incinerator, 70 feet long, would have a nominal capacity of 20 tph for dry wood. The required air curtain is 800 standard cubic feet per minute (scfm) at 10 inches of water pressure per linear foot of open pit. The equivalent power requirement for the air fan drive is about 1.8 hp per linear foot. The cross section of a typical open-pit air-curtain incinerator is shown in Figure VII-1.

The total investment cost including fan, motor, starter and refractory-lined pit is estimated at $15,000. The operating costs have been estimated at $35 per hour, including a crawler tractor with operator and electrical power to drive the fan. On this basis the chargeable cost for the reduction of demolition waste is estimated at $2.00 per ton.

One of the problems encountered by the Pier 22 demolition contractor in operating the open-pit incinerator is the ignition of the



NOMINAL DESIGN PARAMETERS

CAPACITY: 3.4×10^6 BTU/HR./FT.

NOZZLE VELOCITY: 150 MPH

NOZZLE FLOW RATE: 800 SCFM/FT.

NOZZLE DEPRESSION ϕ: 30°

OPEN PIT AIR CURTAIN INCINERATOR

FIGURE VII-1

wood in the pit. Diesel oil was used to start the fire in the pit prior to starting the fan which provides the air curtain across the top of the pit. This starting procedure produces large quantities of black smoke.

The use of gelled petroleum fire boosters which are commercially available for this purpose is a more satisfactory method of ignition. This product is sold by the Standard Oil Company and is called the Chevron Fuel Booster Blivet. These blivets can provide a hotter ignition for a larger amount of wood surface than can be ignited with a comparable amount of diesel oil.

The incinerator could also be equipped with natural gas burners which are also effective for maintaining operating temperatures.

Another source of ignition and burning problems is the use of wet wood. The open-pit incinerator is sometimes charged with wood that has just been brought out of the water. The wood is too wet to allow the fire to approach the temperature required for minimum smoke generation. The demolition projects should be programmed with sufficient time to dry the wood.

The open-pit incinerator will not meet air pollution control emission standards and may be operated only at the pleasure of the PSAPCA. Although the standards will not be met, the aesthetic appearance of this type of burn operation could be greatly enhanced by an investigative program to improve the physical configuration, the air-fuel ratio, and the charging of the pit.

3. Meteorologically Scheduled Open Burn

a. Description

Demolition waste is stacked and dried in large piles and the accumulation of waste from several months' or more demolition activity is burned in a single day's operation. The day selected for the burn is scheduled by a weather forecast to have atmospheric conditions which will be most beneficial to dispersing smoke and will blow the smoke away from population centers. Through proper use of fire starters and boosters (gelled petroleum products), the fire temperatures can be kept high to incinerate more of the combustibles and to minimize smoke production. In this manner, an efficient fire results and only a few

days of burn per year are required. This procedure is also effective for the clean disposal of slash from logging operations and to dispose of clearing and grubbing wastes in construction projects. These materials have more dirt and other noncombustibles than the pier demolition waste.

b. Requirements

There are two prerequisites for the meteorologically scheduled burn operation. The first is the proper site. The site must be large enough to hold the stacks of drying wood prior to firing and to provide an adequate buffer zone around the stacks on the day of the burn. The local fire marshal should be consulted during the selection of the site. As the Port improvement program progresses, there will be less land available for conducting burns unless a site is dedicated for this use for the life of the demolition program.

The second prerequisite is a concurrence from the PSAPCA. Fires for the disposal of waste materials are permitted, provided no alternative means of disposal is reasonably available and permission for such a fire is obtained from the appropriate local agencies, including the Air Pollution Control Officer. This is the same type of permission required to operate the open-pit incinerator. The principal environmental concern is airborne particulate matter and the resulting visibility reduction and fallout. Environmental considerations must also balance the air pollution potential against the alternative loss of landfill disposal capacity.

c. Advantages

There are several advantages to this approach to burning over the continuous open burning operation or the continual operation of the open-pit incinerator.

The heat generated from the meteorologically scheduled burn tends to provide the emissions with greater thermal lift which will reduce the ground level concentrations. The capacity of the atmosphere to disperse the emission from a fire varies by more than a factor of 100 from day to day depending on wind speed, the inversion height, and the stability. Therefore, when burning continuously, the emissions from a fire will sometimes be discharged into the atmosphere and remain at relatively high

concentrations for long distances of airborne travel. The meteorologically scheduled burns would be programmed to occur only when atmospheric conditions provide for a high dilution of the emissions.

Since the weight of particulate emitted per ton of waste burned from a well fired meteorologically scheduled burn and an open-pit incinerator will be about the same, the air pollution impact of the meteorologically scheduled burn is generally less than for the open-pit incinerator. Often a cleaner fire can be achieved with the meteorologically scheduled burn because of its ability to reach and maintain a higher temperature.

d. Procedures

The following discussion of the combustion process and procedures for the conduct of the meteorologically scheduled burn are also generally applicable to open-pit incineration.

The combustion of wood is in two steps. First, the volatiles are driven from the wood and ignite. Second, the remaining heavy residual material, which is almost a coke, burns. The volatiles evolve and will ignite at temperatures between 1,000F and 1,200F. At lower temperatures some of the volatile materials will evaporate but not ignite, and upon condensation they appear as smoke. The wood in the demolition waste is well-seasoned and salt-water leached, and hence a portion of the volatiles has already been removed.

After the volatiles are burned out, the fire is not self-sustaining if the surface temperature of the wood cannot be maintained above the 1,000-1,400F range. The temperature is kept high by minimizing the voids in the stack. With close spacing, the burning surfaces heat each other by radiation, and the amount of air passing through the fire is not so excessive as to cool these surfaces. Although the demolition wood should be tightly stacked to minimize voids, it should not be so tight that the fire will not have sufficient air for combustion. The piles and timbers should be generally parallel with enough cross-stacking to maintain the draft. Smaller material should be distributed throughout the stack. The amounts of dust and noncombustible demolition

waste (e.g., concrete and sheetrock) should be minimized in the stack so that the volatiles will pass through the burning areas above, prior to entering the atmosphere.

Ignition of the wood is accomplished by use of gelled petroleum products previously described. Blivets are placed at the top and will burn holes through the stack. Columns of fire develop in these holes and serve as chimneys. The blivets are placed close enough such that the chimneys would merge.

Conventional equipment is used to work the fire. For most burns, and definitely for those larger than 10,000 tons or more, this would include two larger crawler tractors with blades for "punching up" the stacks as they burn. At the end of the burn, when there is not enough wood remaining to achieve the desired intense heat required for the efficient burning, the fire should be extinguished. Tests have shown that the residual ash from these burns can be as low as 10%. The cost of a 10,000-ton burn is about $0.20 per ton. The cost is exclusive of the stacking which is common to most demolition handling projects. There need not be any removal of the residuals if subsequent burns are planned because the new stack can be built over this material.

D. SIZE REDUCTION OF DEMOLITION WASTE BY MECHANICAL METHODS

Some of the demolition waste is as large as 2.5 feet in diameter and 70 feet long, and it must be reduced to less than 1 foot in diameter and less than 12 feet in length to be suitable for landfill disposal. Therefore, both the length and diameter must be reduced in size. With the exception of shredding and hogging, length and diameter reductions are usually accomplished in separate operations.

1. Sawing

Sawing can reduce the length of the demolition waste, but is impractical for width or diameter reduction. When cross-cutting, the operator can inspect the wood to avoid hitting metals; however, it can still be very hazardous since metal inclusions may not be readily seen. When working with the maximum size pieces of demolition waste, cross-cutting is estimated to cost about $0.60 per ton. However, the large members must still be split to size in order to meet the maximum width limitation, and the estimate does not include this cost.

2. Shearing

Equipment similar to that used to snip off pilings at the mud line during demolition operations can be used to shear the pilings and timber to length. The shearing forces are developed by heavy hydraulic pistons. This equipment is usually custom fabricated in the field by individual contractors. A crane plus two laborers would be required to manipulate the pilings and heavy timber into the snipping machine. The snipping machine would cut the waste to length, and the diameter would also have to be reduced in size. Hydraulically powered wedges to split the demolition waste into the desired widths can be incorporated into the snipping machine. The design of the machine would be dependent on the fabrication material available to the contractor. For estimating purposes, the snipping machine is assumed to have a splitting attachment and to be made of structural steel. The weight of the equipment is assumed to be at least three times greater than the heaviest piece of wood which is processed. A piling 2-1/2 feet in diameter and 70 feet long could weigh nearly 9 tons. Therefore, this machine would weigh about 27 tons. Using a value of $0.80 per pound (1975) for field fabricated steel, the machine would cost about $46,000 if supplied by an independent vendor. However, if field fabricated by a demolition contractor using salvaged materials, the price per pound is estimated at $0.40 or about $23,000. The Port improvement program will generate about 75,000 tons of wood demolition waste by 1985. Over the length of the project, the cost of the equipment would then be charged against processing the waste at a rate of about $0.30 per ton. Operating costs are based on one crane with operator plus two laborers processing four major pilings per hour or about 36 tons per hour. The operating cost is about $1.50 per ton, and combined capital and operating cost is about $1.80 per ton. These costs do not include the loading or haul to the final disposal site. At the 36-tph rate, the machine would have a capacity of about 70,000 tpy which exceeds the rate the demolition waste is being generated.

APPENDIX

PORT OF TACOMA

SOLID WASTE INVENTORY AND PROJECTIONS

A. INTRODUCTION

The solid waste management study for the Port of Tacoma has included the preparation of a solid waste inventory for the Port Complex for the year 1970 and the preparation of solid waste projections for the years 1980 and 2000. Summaries of the solid waste inventory and the solid waste projections are given in Tables A-1 through A-3. These and other tables (A-1 through A-20) are included at the end of the appendix.

The additional tables are presented to provide more detailed information on the solid waste generated within the various areas at the Port Complex. Tables containing inventory data and projections appear in sets of three, one each for the years 1970, 1980 and 2000. Projections are based on changes in the rate at which solid waste will be generated as well as on the growth of the base to which the rate is applied. Tables A-7 through A-9 are for the Port Terminal operations. Tables A-10 through A-12 are for the waterfront industries. Tables A-13 through A-15 are for the nonwaterfront industries.

The 1970 estimate was developed in general from data received in response to questionnaires prepared and distributed by Port personnel. The questionnaires were followed by telephone interviews with the Port tenants. For reference, summaries of these data are given in Tables A-16 through A-18. Since the responses to questionnaires were stated in both volume and mass, the assumed densities are given in Table A-19. The inventory procedure, as expected, did not provide complete data of the solid waste generated, and estimates were necessary to develop a set of working numbers upon which solid waste management criteria could be established.

B. ORGANIZATION OF THE INVENTORY

In order to develop a solid waste inventory, the activities and the areas of the Port complex were subdivided. For each subdivision, a narrative description of the categories of waste generated are given to provide general background information. The industries within each subdivision have been classified as to general type, and the Standard Industrial Classification (SIC)[14] system has been used to identify the various type of industries.

Solid waste sources are grouped according to the various areas and activities within the Port Complex as follows:

- Port terminal activities
  - Terminal operation - Port operated
  - Terminal operation - commercially operated by others
  - Shipboard
  - Demolition
- Waterfront area industries
- Nonwaterfront area industries

Industries in the Port Terminal Area, Industrial Yard, and the Industrial Development District, are designated as waterfront industry if they are located on the waterfront, regardless of activity. All others are designated as nonwaterfront industries. Of the present total of 199 industries in the three locations, 33 are waterfront industries and the remaining 166 are nonwaterfront industries.

1. Terminal Operations - Port Operated

This activity is mainly related to vessel and cargo handling; cold storage facilities; cool room facilities; commercial fishing marina; housekeeping of piers, warehouses and offices; and maintenance of piers, warehouses, buildings and utilities.

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[14]U.S. Federal Committee on Industrial Classification. Standard industrial classification manual, 1967. Bureau of the Budget, Executive Office of the President. 1967.

Solid waste material originating from cargo operations and vessel calls includes dunnage, scrap, wire, pallet boards, paper, glass, plastic and putrescibles. Routine waste is picked up daily by the Port's sweeping crew and delivered to the central receiving bin. The bin has a 25-cubic-yard capacity and is collected daily by the City of Tacoma.

Seasonal wastes, such as plastic and paper fruit boxes and waste fruit, are accumulated and hauled to the City of Tacoma disposal site. Condemned meat is given to a local rendering firm.

The Port operates a cool room facility for the receipt of fruit. This facility is made up of three rooms having a total estimated capacity of 30,000 cases. To date no wastage has been incurred, but provision is made for the fumigation and disposal of condemned fruit to provide for any unforeseen mishap in the handling of this commodity.

Three 55-gallon drums containing dunnage, paper, metal and glass from the Marina are picked up daily by the Port's sweeping crew and deposited in the Port's central receiving bin. The Port-operated commercial fishing boat marina has 122 berths.

Normal housekeeping waste is collected daily by the Port's sweeping crew and delivered to the Port's central receiving bin. This waste consists of dock, warehouse and building sweepings, office waste, and all other wastes deposited in bins or barrels located at each facility.

Maintenance wastes are collected by the Port's sweeping crew and deposited in the central receiving bins. Maintenance material includes creosoted and uncreosoted timber from the repair of piers and buildings, and wood scrap and dunnage from pallet boards and related items. Broken, unrepairable pallet boards are deposited in the Port's central storage bin. Creosoted railroad ties, which are continually being replaced in the railroad maintenance program, are stockpiled on Port property for public pickup. The public demand for the railroad ties eliminates the need for special disposal.

2. Terminal Operations - Commercially Operated

Terminal facilities leased by the Port include grain, ore and bulk liquid (e.g., tallow, chemicals) handling facilities.

The grain terminal facility wastes approximately 1 ton per week of seeds and cracked wheat from the grain elevator washer screens. Every 2 weeks a local farmer picks up this waste for use as livestock feed.

Dunnage from the operation of leased facilities is disposed of by the lessee. Scrap metal is stockpiled and sold every 3 to 4 months to local salvage operations.

Wastes from the alumina facility are nominal in quantity because environmental control equipment returns the alumina dust to the product stream. The only waste generated by the alumina facility occurs during the infrequent mechanical failures of the dust collection equipment. These minor quantities are buried on site.

All wastes from the liquid (tallow) bulk facility are picked up by the City. These wastes include a monthly pickup of an 8-foot-by-8-foot bin containing about 90% paper. Five times per month the City picks up 2.5 tons of spent clay and diatomaceous earth containing oil used in the tallow bleaching process.

A frozen-food processing firm generates wastes similar to the Port-operated cold storage facility. This firm collects and disposes of its own waste material.

3. Shipboard Waste

This category consists of all solid waste originating on board ship either prior to or while in port and includes rubbish and food garbage generated by the ship's crew, waste cargo and dunnage, and ship maintenance refuse. Active cargo vessels berth between 8 hours to 4 days, with an average berthing time of 2-1/2 days. Solid shipboard waste does not include sanitary waste.

Overboard disposal of all wastes is prohibited. Arrangements for the collection of the shipboard wastes are made by the local shipping agency representing the vessel with the City collection service.

4. Waterfront Industries

Thirty-three industries are presently classified as waterfront industries, five of which are located in the Industrial Yard and the balance in the Industrial Development District.

Industries presently classified as waterfront industries due to their present location and type of industrial activity are identified in Table A-4. The SIC system was used to facilitate the collection of solid waste data by bringing together industries with the same type of operations and thus with similar types of solid wastes. The application of the SIC system to the solid wastes produced by the industries at the Port of Tacoma is illustrated in Tables A-5 and A-6. SIC designations numbering from 16 to 89 cover the complete cross section of industries located within the Port Complex.

The 33 waterfront industries and also the 166 nonwaterfront industries are identified by the 34 industrial classification groups. As many as 40 industries may be listed under one classification number.

5. Nonwaterfront Industries

Industries in this category at present number 166. These industries are not necessarily dependent on a waterfront location for their operation. However, these industries are typical of the categories expected to occupy the remaining 600 acres of land available for industrial development which does not have direct access to water.

C. CHANGES IN THE TYPES OF SOLID WASTE GENERATED

The types of solid waste being generated within the Port Complex were reviewed to determine if any significant change in type of solid waste from a specific source could be projected.

1. Wastes Originating on Board Ship

While current collection practice is separate and distinct from existing Port responsibility, a future collection system under City jurisdiction should plan for the systematic handling of this refuse. The shipboard wastes are assumed to be proportional to the tonnage of ships visiting the Port. Trends in shipping indicate smaller crews per ton of cargo handled, and therefore the projections may be conservative. However, no radical change is expected in the types of waste generated on shipboard.

2. Dunnage Wastes

The current trend toward containerization would tend to decrease dunnage waste. However, if a portion of containerized cargoes are packaged and unpackaged on or near site, this would provide an additional source of waste. The decreases in dunnage resulting from improved cargo handling techniques are assumed to be offset by increase in dunnage from containerpacking. Overall, dunnage wastes are expected to increase in proportion to the tonnage of cargo handled.

3. Terminal Housekeeping Wastes

Wastes such as dock sweepings, wire strap, paper and scrap wood, which make up a major part of the existing housekeeping waste are projected to increase in proportion to the tonnage of cargo handled.

4. Port Maintenance Wastes

During the next 10 years the maintenance of timber piers, warehouses, roads and railroads will continue as in the past. Thereafter, pier maintenance will decline as new concrete pier facilities replace their obsolete timber counterparts.

5. Demolition and Construction Wastes

Major quantities will be intermittent until after 1985 when the scheduled pier demolition program will be completed.

D. PROJECTIONS OF SOLID WASTE GENERATED AT THE PORT COMPLEX

The substantial growth of cargo through the Port of Tacoma has been the result of increasing shipments of the major commodities of general cargo, logs and ore. The Port expects the growth rate to continue, based on commitments from present and prospective users.

The projected growth rates for the major shipping commodities are presented in Table A-6. These growth rates are based on historical trends, and growth indices obtained from the following sources:

U. S. Department of the Interior, Bonneville Power Administration. Pacific Northwest Economic Base Study for Power Markets: Volume I: Summary. 1970.

Puget Sound Task Force of the Pacific Northwest River Basins Commission, Navigation Technical Committee. Comprehensive Study of Water and Selected Land Resources: Puget Sound and Adjacent Waters: Appendix VIII: Navigation. March 1970.

The growth rate for general cargo is estimated at approximately 10% per year. Log shipments have increased in the past at a rate of 15% per year, and this rate is consistent with a U. S. Forest Service projection.[15]

Lumber and grain cargoes are assumed to maintain a relatively constant traffic in the future. Alumina and other ores are projected at a future annual growth rate of 3 percent.

1. Terminal Activities

The wastes from terminal activities are a direct function of the amount of waterborne cargo handled by the Port. Based on cargo

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[15]Austin, J. W. Production, prices, employment, and trade in Northwest forest industries: second quarter. Pacific Northwest Forest and Range Experiment Station, U. S. Forest Service, Agriculture Dept., Portland, Oregon, 1970.

projections, solid wastes from vessel and cargo handling, terminal housekeeping and shipboard waste are projected to increase by a factor of 1.66 between 1970 and 1980. Projections of waste from the operation of cold storage facilities are based on a factor of 1.5 from 1970 to 1980.

Projections of marina wastes are based on plans for future marina facilities with five times the number of berths in 1970.

Future maintenance wastes are based on the growth of existing and planned facilities and are projected to increase by a factor of 1.8 from 1970 to 1980.

Demolition and construction wastes have been estimated for known projects scheduled to take place between 1970 and 1985.

A factor of 1.4 has been used in projecting wastes from the grain terminal facilities and a factor of 1.5 for wastes from the bulk alumina ore facilities for the period of 1970 to 1980.

The 1980 estimate of solid waste from the bulk liquid handling facilities is projected at 1.65 times the 1970 quantity.

From 1980 through the year 2000 the annual rate of increase for solid waste generated by Port activities is estimated at 3% per year for all sources. The 1970 waste inventory and projections for 1980 and 2000 are given in Tables A-7 through A-9.

2. Waterfront Industries

The number of waterfront industries are expected to increase from 33 to 48 by the year 1980. Projections in acreage and waterfront footage for the applicable SIC are presented in Table A-5. The ratio of the 1980 waterfront footage to 1970 waterfront footage for each SIC category is numerically equal to the growth factor. From 1980 through the year 2000, a 3% per year growth in solid waste generation was assumed. The 1970 waste inventory and projections for 1980 and 2000 are given in Tables A-10 through A-12.

3. Nonwaterfront Industries

An estimated 45 industries from the industrial yard and terminal area are planned for relocation to available sites in the Industrial Development District by 1980. In this manner the starting base of 166 nonwaterfront industries will not be changed by the relocation. The growth rates presented in Table A-6 by SIC category are for the 166 industries as well as the expected influx of new industries into the Industrial Development District. Thus, the industrial growth factor considers both the increase in number of industries and the increases in production of individual industries. From 1980 to the year 2000, the growth rate of the nonwaterfront industries is estimated at 3% per year. The 1970 inventory and 1980 and 2000 solid waste projections are given in Tables A13 through 15.

TABLE A-1
PORT OF TACOMA SOLID WASTE INVENTORY 1970
TONS PER YEAR

Waste Category	LANDFILL DISPOSAL					SALVAGE					TOTAL LANDFILL DISPOSAL PLUS SALVAGE				
	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex
	Port operated	Leased				Port operated	Leased				Port operated	Leased			
1. Wood--demolition	14,340	-*	-	-	14,340	-	-	-	-	-	14,340	-	-	-	14,340
2. Wood--other	580	10	9,310	5,530	15,430	90	-	-	9,410	9,500	670	10	9,310	14,940	24,930
3. Paper	190	50	830	2,720	3,790	-	-	-	730	730	190	50	830	3,450	4,520
4. Metal	310	110	150	550	1,120	-	-	8,960	4,550	13,510	310	110	9,110	5,100	14,630
5. Glass	80	-	250	80	410	-	-	-	-	-	80	-	250	80	410
6. Fiber, plastics, rubber	-	-	30	1,470	1,500	-	-	-	-	-	-	-	30	1,470	1,500
7. Minerals	20	150	22,520	7,150	29,840	-	-	-	-	-	20	150	22,520	7,150	29,840
8. Putrescibles	1,070	20	60	350	1,500	-	-	-	-	-	1,070	20	60	350	1,500
9. Special waste															
Chemicals	10	-	630	550	1,190	-	-	-	-	-	10	-	630	550	1,190
Paints & petroleum	-	-	170	170	340	-	-	-	-	-	-	-	170	170	340
Condemned food	500	-	-	-	500	-	-	-	-	-	500	-	-	-	500
Hazardous wastes	-	-	10	-	10	-	-	-	-	-	-	-	10	-	10
Other	-	-	-	-	-	-	-	320	-	320	-	-	320	-	320
TOTALS	17,100	340	33,960	18,570	69,970	90	-	9,280	14,690	24,060	17,190	340	43,240	33,260	94,030

* Dashes (-) indicate quantities of less than 5 TPY

TABLE A-2
PORT OF TACOMA SOLID WASTE PROJECTIONS 1980
TONS PER YEAR

Waste Category	LANDFILL DISPOSAL					SALVAGE					TOTAL LANDFILL DISPOSAL PLUS SALVAGE				
	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex
	Port operated	Leased				Port operated	Leased				Port operated	Leased			
1. Wood--demolition	24,500	-	-	-	24,500	-	-	-	-	-	24,500	-	-	-	24,500
2. Wood--other	990	10	15,140	8,400	24,540	160	-	-	14,750	14,910	1,150	10	15,140	23,150	39,450
3. Paper	320	50	1,350	3,960	5,680	-	-	-	1,040	1,040	320	50	1,350	5,000	6,720
4. Metal	420	170	150	600	1,340	-	-	15,000	6,270	21,270	420	170	15,150	6,870	22,610
5. Glass	290	-	410	110	810	-	-	-	-	-	290	-	410	110	810
6. Fiber, plastics, rubber	10	-	60	2,080	2,150	-	-	-	-	-	10	-	60	2,080	2,150
7. Minerals	20	250	41,710	9,690	51,670	-	-	-	-	-	20	250	41,710	9,690	51,670
8. Putrescibles	1,740	20	80	550	2,390	-	-	-	-	-	1,740	20	80	550	2,390
9. Special waste															
Chemicals	20	-	1,060	750	1,830	-	-	-	-	-	20	-	1,060	750	1,830
Paints & petroleum	-	-	260	240	500	-	-	-	-	-	-	-	260	240	500
Condemned food	830	-	-	-	830	-	-	-	-	-	830	-	-	-	830
Hazardous wastes	-	-	20	-	20	-	-	-	-	-	-	-	20	-	20
Other	9,470	-	-	-	9,470	-	-	540	-	540	9,470	-	540	-	10,010
TOTALS	38,610	500	60,240	26,380	125,730	160	-	15,540	22,060	37,760	38,770	500	75,780	48,440	163,490

*Dashes (-) indicate quantities of less than 5 TPY

TABLE A-3
PORT OF TACOMA SOLID WASTE PROJECTIONS 2000
TONS PER YEAR

Waste Category	LANDFILL DISPOSAL					SALVAGE					TOTAL LANDFILL PLUS SALVAGE				
	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex	Terminal Operations		Waterfront Industries	Non-Waterfront Industries	Total Port Complex
	Port operated	Leased				Port operated	Leased				Port operated	Leased			
1. Wood--Demolition	190	-*	-	-	190	-	-	-	-	-	190	-	-	-	190
2. Wood--other	1,760	40	27,370	15,250	44,420	310	-	-	26,500	26,810	2,070	40	27,370	41,750	71,230
3. Paper	570	130	2,390	7,150	10,240	-	-	-	1,870	1,870	570	130	2,390	9,020	12,110
4. Metal	480	290	290	1,100	2,160	-	-	27,000	11,310	38,310	480	290	27,290	12,410	40,470
5. Glass	480	-	750	290	1,520	-	-	-	-	-	480	-	750	290	1,520
6. Fiber, plastic, rubber	20	-	110	3,750	3,880	-	-	-	-	-	20	-	110	3,750	3,880
7. Minerals	40	450	75,270	17,490	93,250	-	-	-	-	-	40	450	75,270	17,490	93,250
8. Putrescibles	3,220	40	130	980	4,370	-	-	-	-	-	3,220	40	130	980	4,370
9. Special waste															
Chemicals	40	-	1,910	1,340	3,290	-	-	-	-	-	40	-	1,910	1,340	3,290
Paints & Petroleum	-	-	460	420	880	-	-	-	-	-	-	-	460	420	880
Condemned food	1,500	-	-	-	1,500	-	-	-	-	-	1,500	-	-	-	1,500
Hazardous wastes	-	-	40	-	40	-	-	-	-	-	-	-	40	-	40
Other	-	-	-	-	-	-	-	970	-	970	-	-	970	-	970
TOTALS	8,300	950	108,720	47,770	165,740	310	-	27,970	39,680	67,960	8,610	950	136,690	87,450	233,700

*Dashes (-) indicate quantities of less than 5 TPY

TABLE A-4

PORT OF TACOMA WATERFRONT INDUSTRIES

Standard Industrial Classification Number	Year 1970			Year 1980			Growth Factor: Ratio of 1980 Waterfront Footage to the 1970 Waterfront Footage
	Number of Industries	Acreage	Waterfront Footage	Number of Industries	Acreage	Waterfront Footage	
16	2	27	1,000	3	35	1,500	1.50
24	2	45	1,200	3	60	2,000	1.67
28	4	147	7,200	6	195	12,000	1.67
29	1	15	2,500	1	15	2,500	1.00
32	1	14	200	2	20	500	2.50
32	1	98	2,100	2	130	3,500	1.67
37	6	46	2,900	10	60	4,700	1.62
42	4	115	5,900	6	150	9,500	1.61
46	1	2	400	1	2	400	1.00
50	7	63	4,500	11	85	7,500	1.67
75	1	2	200	1	2	200	1.00
58	1	2	300	1	2	450	1.50
Public Marina	1	-	200	1	-	500	2.00
TOTAL	32	576	28,600	48	752	45,250	--

TABLE A-5
PORT OF TACOMA NON-WATERFRONT INDUSTRIES

SIC Category	1970 Number of Industries	1970 Acres	1980 Number of Industries	1980 Acres	Industrial Growth Factor
16	2	6	1	6	1.15
17	4	6	5	8	1.15
20	2	2	3	3	1.50
22	1	2	1	2	1.00
23	1	1	1	1	1.00
24	12	120	18	180	1.50
25	6	42	9	63	1.50
26	5	20	7	26	1.30
28	7	178	10	267	1.50
29	1	10	1	14	1.40
30	5	30	7	39	1.30
32	1	1	2	2	1.50
33	1	32	1	42	1.30
34	5	22	6	26	1.20
35	9	17	13	26	1.50
36	2	5	3	8	1.50
37	2	1	3	2	1.50
39	1	-	3	1	1.50
42	18	314	33	575	1.60
44	7	7	11	13	1.60
46	1	2	1	2	1.00
47	1	1	1	2	1.40
49	2	25	3	35	1.40
50	31	116	40	150	1.30
60	2	2	3	3	1.50
65	1	1	1	1	1.20
72	1	1	2	2	1.60
73	6	6	10	10	1.60
75	2	4	3	6	1.60
76	6	4	10	7	1.60
89	1	2	1	2	1.00
TOTALS	146	950	214	1,540	-

TABLE A-6

PORT OF TACOMA CARGO PROTECTION
THOUSANDS OF TONS

Year	General Cargo	Lumber and Logs	Bulk	Total
1971	623	1,705	1,287	3,616
1972	691	1,866	1,335	3,892
1973	759	2,027	1,381	4,167
1974	827	2,188	1,429	4,444
1975	895	2,349	1,457	4,701
1976	963	2,510	1,480	4,953
1980				6,000

TABLE A-7

SOLID WASTE GENERATED BY PORT OF TACOMA TERMINAL OPERATIONS AND RELATED ACTIVITIES 1970

TONS PER YEAR

Industry Classification	Demolition Wood	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES				
									Chemicals	Petroleum & Paints	Condemned Food	Hazardous Wastes	Other Wastes
TERMINAL OPERATIONS PORT OPERATED													
Cargo operations; housekeeping	-*	580	140	40	10	-	10	10	10	-	-	-	-
Cold storage	-	10	10	10	-	-	-	30	-	-	-	-	-
Cool room	-	10	10	10	-	-	-	30	-	-	-	-	-
Maintenance	60	60	20	20	20	-	10	-	10	-	-	-	-
Commercial fishing marina	-	-	-	10	50	-	-	-	-	-	-	-	-
Sub Total	60	660	180	90	80	-	20	70	10	-	-	-	-
TERMINAL OPERATIONS--LEASED													
Grain elevator	-	10	10	40	-	-	-	-	-	-	-	-	-
Bulk--alumina ore	-	-	10	30	-	-	10	-	-	-	-	-	-
Bulk liquid	-	-	10	30	-	-	140	-	-	-	-	-	-
Frozen food processing	-	-	20	10	-	-	-	20	-	-	-	-	-
Sub Total	-	10	50	110	-	-	150	20	-	-	-	-	-
SHIPBOARD WASTE	-	10	10	70	-	-	-	1,000	-	-	500	-	-
DEMOLITION WASTE	14,280	-	-	150	-	-	-	-	-	-	-	-	-
TOTAL	14,340	680	240	420	80	-	170	1,090	10	-	500	-	-
Distribution of Total													
Amount salvaged	-	90	-	-	-	-	-	-	-	-	-	-	-
Amount to landfill	14,340	590	240	420	80	-	170	1,090	10	-	500	-	-

* Dashes (-) indicate quantities of less than 5 TPY

TABLE A-8

SOLID WASTE GENERATED BY PORT OF TACOMA TERMINAL OPERATIONS AND RELATED ACTIVITIES 1980

TONS PER YEAR

	Growth Factor (1970-1990)	Demolition Wood	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES				
										Chemicals	Petroleum & Paints	Contaminated Food	Hazardous Wastes	Other Wastes
Industry Classification														
TERMINAL OPERATIONS: PORT OPERATED														
Cargo operations; housekeeping	1.66	-*	960	220	60	10	10	10	10	10	-	-	-	-
Cold storage	1.50	-	20	10	10	-	-	-	50	-	-	-	-	-
Cool room	1.50	-	20	20	10	-	-	-	50	-	-	-	-	-
Maintenance	1.80	110	120	40	40	30	-	10	-	10	-	-	-	-
Commercial fishing marina	5.0	-	10	10	50	230	-	-	20	-	-	-	-	-
Sub Total		110	1,130	300	170	270	10	20	80	20	-	-	-	-
TERMINAL OPERATIONS; LEASED														
Grain elevator	1.40	-	10	10	50	-	-	-	-	-	-	-	-	-
Bulk--alumina ore	1.50	-	-	10	50	-	-	20	-	-	-	-	-	-
Bulk--liquid	1.65	-	-	10	50	-	-	230	-	-	-	-	-	-
Frozen food processing	1.50	-	-	20	20	-	-	-	20	-	-	-	-	-
Sub Total		-	10	50	170	-	-	250	20	-	-	-	-	-
SHIPBOARD WASTE	1.66	-	20	20	110	-	-	-	1,660	-	-	830	-	-
DEMOLITION WASTE		24,390	-	-	140	20	-	-	-	-	-	-	-	9,470
TOTALS		24,500	1,160	370	590	290	10	270	1,760	20	-	830	-	9,470
Amount salvaged (same % as 1970)		-	160	-	-	-	-	-	-	-	-	-	-	-
Amount to Landfill (same % as 1970)		24,500	1,000	370	590	290	10	270	1,760	20	-	830	-	9,470

* Dashes (-) indicate quantities of less than 5 TPY

TABLE A-9

SOLID WASTE PROJECTIONS FOR PORT OF TACOMA TERMINAL OPERATIONS AND RELATED ACTIVITIES 2000
TONS PER YEAR

Industry Classification	Growth Factor (1970-2000)	Demolition Wood	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES: Chemicals	Petroleum & Paints	Condemned Food	Hazardous [illegible]	Other [illegible]
TERMINAL OPERATIONS: PORT OPERATED														
Cargo operations; housekeeping	3.00	-*	1,740	400	110	20	10	20	20	20	-	-	-	-
Cold storage	2.71	-	40	20	10	-	-	-	80	-	-	-	-	-
Cool room	2.71	-	30	30	10	-	-	-	80	-	-	-	-	-
Maintenance	3.25	190	210	70	70	50	-	20	-	20	-	-	-	-
Commercial fishing marina	9.02	-	20	20	80	410	10	-	40	-	-	-	-	-
Sub Total		190	2,040	540	280	480	20	40	220	40	-	-	-	-
TERMINAL OPERATIONS; LEASED														
Grain elevator	2.53	-	30	30	90	-	-	-	-	-	-	-	-	-
Bulk--alumina ore	2.71	-	-	30	80	-	-	30	-	-	-	-	-	-
Bulk--liquid	2.98	-	-	30	90	-	-	420	-	-	-	-	-	-
Frozen food processing	2.71	-	10	40	30	-	-	-	40	-	-	-	-	-
Sub Total		-	40	130	290	-	-	450	40	-	-	-	-	-
SHIPBOARD WASTE	3.00	-	30	30	200	-	-	-	3,000	-	-	1,500	-	-
DEMOLITION WASTE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS		10	2,110	700	770	480	20	490	3,260	40	-	1,500	-	-
Amount salvaged (same % as 1970)		-	310	-	-	-	-	-	-	-	-	-	-	-
Amount to Landfill (same % as 1970)		10	1,800	700	770	480	20	490	3,260	40	-	1,500	-	-

* Dashes (-) indicate quantities of less than 5 TPY

TABLE A-10
PORT OF TACOMA
SOLID WASTE GENERATED BY WATERFRONT INDUSTRIES 1970
TONS PER YEAR

STANDARD INDUSTRIAL CLASSIFICATION Description	No.	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES Chemicals	Petroleum & Paints	Condemned Food	Hazardous Wastes	Other Wastes
Construction--other than building	16	850	60	50	-*	10	680	-	-	-	-	-	-
Lumber & wood products, except furniture	24	1,720	10	10	-	-	-	-	-	-	-	-	-
Chemicals and allied products	28	10	190	260	50	-	14,950	-	600	-	-	10	200
Petroleum refining & related industries	29	-	-	-	-	-	-	-	10	20	-	-	-
Stone, glass, clay & concrete products	32	120	-	-	-	-	5,200	-	10	-	-	-	-
Primary metal industries	33	120	120	30	-	-	160	-	10	-	-	-	120
Transportation equipment	37	1,060	80	130	110	-	-	-	-	-	-	-	-
Motor freight transportation & warehousing	42	5,040	90	-	-	-	-		-	-	-	-	-
Pipeline transportation	46	-	-	-	-	-	-	-	-	-	-	-	-
Wholesale trade	50	350	260	8,620	40	20	1,330	-	-	140	-	-	-
Eating and drinking places	58	-	10	-	-	-	-	50	-	-	-	-	-
Auto repair, auto services & garages	75	-	-	10	-	-	-	-	-	-	-	-	-
Public marina	-	-	10	-	50	-	-	10	-	10	-	-	-
TOTALS		9,310	830	9,110	250	30	22,520	60	630	170	-	10	320
Amount salvaged	-	-	-	8,960	-	-	-	-	-	-	-	-	320
Amount to landfill	-	9,310	830	150	250	30	22,520	60	630	170	-	10	-

*Dashes (-) indicate quantities of less than 5 TPY

TABLE A-11
PORT OF TACOMA
SOLID WASTE PROJECTIONS FOR WATERFRONT INDUSTRIES 1980
TONS PER YEAR

STANDARD INDUSTRIAL CLASSIFICATION Description	No.	Growth Factor 1970-1980	Wood	Paper	Metal	Glass	Fiber, Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES Chemicals	Petroleum	Contained Food	Hazardous Wastes	Other Wastes
Construction, other than building	16	1.50	1340	90	80	-	20	1,320	-	-	-	-	-	-
Lumber & wood products--except furniture	24	1.67	2870	20	10	-	-	-	-	-	-	-	-	-
Chemicals and allied products	28	1.67	20	310	430	80	-	24,900	-	1,000	-	-	20	340
Petroleum refining & related industries	29	1.00	- *	-	-	-	-	-		10	20	-	-	-
Stone, clay, glass, & concrete products	32	2.50	300	-	-	-	-	13,000	-	30	-	-	-	-
Primary metal industries	33	1.27	200	200	50	-	-	270	-	20	-	-	-	200
Transportation equipment	37	1.62	1720	130	210	170	-	-	-	-	-	-	-	-
Motor freight transportation & warehousing	42	1.61	8110	140	-	-	-	-	-	-	-	-	-	-
Pipeline transportation	46	1.00	-	-	-	-	-	-	-	-	230	-	-	-
Wholesale trade	50	1.67	580	440	14,360	60	40	2,220	-	-	-	-	-	-
Eating and drinking places	58	1.50	-	10	-	-	-	-	70	-	-	-	-	-
Auto repair, auto services, and garages	75	1.00	-	-	10	-	-	-	-	-	-	-	-	-
Public marina	-	2.00	-	10	-	100	-	-	10	-	10	-	-	-
Amount salvaged (same % as 1970)			-	-	15,000	-	-	-	-	-	-	-	-	540
Amount to landfill (same % as 1970)			15,140	1,350	150	410	60	41,710	80	1,060	260	-	20	-
TOTALS			15,140	1,350	15,150	410	60	41,710	80	1,060	260	-	20	540

*Lashes (-) indicate quantities of less than 5 TPY

TABLE A-12
PORT OF TACOMA
SOLID WASTE PROJECTIONS FOR WATERFRONT INDUSTRIES 2000
TONS PER YEAR

STANDARD INDUSTRIAL CLASSIFICATION Description	No.	From 1980 Base	Wood	Paper	Metal	Glass	Fiber, Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES Chemicals	Petroleum	Condemned Food	Hazardous Wastes	Other Wastes
Construction, other than building	16	1.8	2390	150	150	-	30	2,390	-	-	-	-	-	-
Lumber & wood products--except furniture	24	1.8	5180	40	10	-	-	-	-	-	-	-	-	-
Chemicals and allied products	28	1.8	40	560	790	150	-	45,000	-	1,800	-	-	40	610
Petroleum refining & related industries	29	1.8	- *	-	-	-	-	-	-	20	40	-	-	-
Stone, clay, glass, & concrete products	32	1.8	540	-	-	-	-	23,400	-	50	-	-	-	-
Primary metal industries	33	1.8	300	360	90	-	-	480	-	40	-	-	-	360
Transportation equipment	37	1.8	3100	230	280	310	-	-	-	-	-	-	-	-
Motor freight transportation & warehousing	42	1.8	14700	240	-	-	-	-	-	-	-	-	-	-
Pipeline transportation	46	1.8	-	-	-	-	-	-	-	-	-	-	-	-
Wholesale trade	50	1.8	1060	790	25,950	110	80	4,000	-	-	410	-	-	-
Eating and drinking places	58	1.8	-	10	-	-	-	-	120	-	-	-	-	-
Auto repair, auto services, and garages	75	1.8	-	-	20	-	-	-	-	-	-	-	-	-
Public marina	-	1.8	-	10	-	180	-	-	10	-	10	-	-	-
Amount salvaged (same % as 1970)			-	-	27,000	-	-	-	-	-	-	-	-	370
Amount to landfill (same % as 1970)			27370	2,390	290	750	110	75,270	130	1,910	460	-	40	
TOTALS			27370	2,390	27,290	750	110	75,270	130	1,910	460	-	40	970

* Dashes (-) indicate quantities of less than 5 TPY

TABLE A-13
PORT OF TACOMA
SOLID WASTE GENERATED BY NON-WATERFRONT INDUSTRIES 1970
TONS PER YEAR

STANDARD INDUSTRIAL CLASSIFICATION Description	No.	Demolition Wood	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES Chemicals	Paints & Petroleum	Condemned Food	Hazardous Wastes	Other Wastes
Construction--other than building	16	-*	10	10	10	-	-	-	-	-	-	-	-	-
Construction--special trade contractors	17	-	30	10	10	-	-	-	-	-	60	0	-	-
Food & kindred products	20	-	20	20	10	-	-	-	150	-	-	-	-	-
Textile mill products	22	-	-	-	-	-	-	-	-	-	-	-	-	-
Apparel & other finished products made from fabrics	23	-	-	-	-	-	50	-	-	-	-	-	-	-
Lumber & wood products, except furniture	24	-	7,900	100	30	-	-	-	10	-	-	-	-	-
Furniture and fixtures	25	-	2,960	290	100	-	700	-	-	-	-	-	-	-
Paper & allied products	26	-	160	830	30	-	-	-	10	-	-	-	-	-
Chemicals and allied products	28	-	70	150	50	-	-	100	-	-	-	-	-	-
Petroleum refining & related industries	29	-	-	100	200	-	-	3,500	-	-	-	-	-	-
Rubber & misc. plastics products	30	-	10	310	-	-	320	-	-	420	-	-	-	-
Stone, glass, clay & concrete products	32	-	10	-	-	-	30	-	-	20	-	-	-	-
Primary metal industries	33	-	-	-	-	-	-	3,510	-	-	-	-	-	-
Fabricated metal products	34	-	70	140	10	-	-	-	-	-	-	-	-	-
Machinery, except electrical	35	-	30	90	600	-	-	20	-	-	-	-	-	-
Electrical machinery	36	-	10	20	90	-	10	-	-	-	-	-	-	-
Transportation equipment	37	-	10	10	10	-	10	-	-	30	-	-	-	-
Misc. manufacturing industries	39	-	10	10	10	-	-	-	-	-	10	-	-	-
Motor freight transportation & warehousing	42	-	3,030	540	60	-	50	-	20	-	60	40	-	-
Water transportation	44	-	10	20	-	-	-	-	-	-	-	-	-	-
Pipeline transportation	46	-	-	-	-	-	-	-	-	-	-	-	-	-
Transportation services	47	-	40	10	30	-	-	-	-	-	-	-	-	-
Electric, gas and sanitary services	49	-	-	10	-	-	-	-	-	-	-	-	-	-
Wholesale trade	50	-	520	420	3,820	50	260	-	90	10	-	-	-	-
Building, Matls., hardware & farm equipment dealers	52	-	-	20	-	-	-	-	-	-	-	-	-	-
Auto dealers & gas service stations	55	-	10	10	10	10	20	-	-	-	30	-	-	-
Eating and drinking places	58	-	10	100	-	10	-	-	90	-	-	-	-	-
Banking	60	-	-	10	-	-	-	-	-	-	-	-	-	-
Real Estate	65	-	-	-	-	-	-	-	-	-	-	-	-	-
Personal services	72	-	-	-	-	-	-	-	-	10	-	-	-	-
Misc. business services	73	-	-	130	-	-	-	-	-	-	-	-	-	-
Auto repair, auto services & garages	75	-	10	10	10	10	20	-	-	-	30	-	-	-
Misc. repair services	76	-	10	80	10	-	-	-	-	-	-	-	-	-
Misc. services	89	-	-	-	-	-	-	-	-	-	-	-	-	-
Amount salvaged (used same % as 1970)		-	9,410	730	4,550	-	-	-	-	-	-	-	-	-
Amount to landfill (used same % as 1970)		-	5,530	2,720	550	80	1,470	7,150	350	550	170	-	-	-
TOTALS		-	14,940	3,450	5,100	80	1,470	7,150	350	550	170	-	-	-

*Dashes (-) indicate quantities of less than 5 TPY

TABLE A-14
PORT OF TACOMA
SOLID WASTE PROJECTIONS FOR NON-WATERFRONT INDUSTRIES 1980
TONS PER YEAR

STANDARD INDUSTRIAL CLASSIFICATION Description	No.	Growth Factor (1970-1980)	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES Chemicals	Petroleum	Condemned Food	Hazardous Wastes	Other Wastes
Construction--other than building	16	1.15	10	10	10	-*	-	-	-	-	-	-	-	-
Construction--special trade contractors	17	1.15	40	10	10	-	-	-	-	-	70	-	-	-
Food & kindred products	20	1.50	30	30	20	-	-	-	230	-	-	-	-	-
Textile mill products	22	1.00	-	-	-	-	-	-	-	-	-	-	-	-
Apparel & other finished products made from fabrics	23	1.00	-	-	-	-	50	-	-	-	-	-	-	-
Lumber & wood products, except furniture	24	1.50	11,850	150	50	-	-	-	20	-	-	-	-	-
Furniture and fixtures	25	1.50	4,430	430	150	-	1050	-	-	-	-	-	-	-
Paper & allied products	26	1.30	210	1080	40	-	-	-	10	-	-	-	-	-
Chemicals and allied products	28	1.50	110	220	70	-	-	150	-	-	-	-	-	-
Petroleum refining & related industries	29	1.40	-	140	280	-	-	4300	-	-	-	-	-	-
Rubber & misc. plastics products	30	1.30	10	400	-	-	410	-	-	550	-	-	-	-
Stone, glass, clay & concrete products	32	1.50	20	-	-	-	50	-	-	30	-	-	-	-
Primary metal industries	33	1.30	-	-	-	-	-	4570	-	-	-	-	-	-
Fabricated metal products	34	1.20	80	170	10	-	-	-	-	-	-	-	-	-
Machinery, except electrical	35	1.50	50	130	900	-	-	30	-	-	-	-	-	-
Electrical machinery	36	1.50	20	30	130	-	20	-	-	-	-	-	-	-
Transportation equipment	37	1.50	20	20	20	-	10	-	-	40	-	-	-	-
Misc. manufacturing industries	39	1.50	20	20	10	-	-	-	-	-	20	-	-	-
Motor freight transportation & warehousing	42	1.80	5,450	960	110	-	90	40	-	110	70	-	-	-
Water transportation	44	1.60	20	30	-	-	-	-	-	-	-	-	-	-
Pipeline transportation	46	1.00	-	-	-	-	-	-	-	-	-	-	-	-
Transportation services	47	1.40	60	10	40	-	-	-	-	-	-	-	-	-
Electric, gas and sanitary services	49	1.40	-	10	-	-	-	-	-	-	-	-	-	-
Wholesale trade	50	1.30	680	540	4970	70	340	-	120	10	-	-	-	-
Building, Matls., hardware & farm equipment dealers	52	2.00	-	40	-	-	-	-	-	-	-	-	-	-
Auto dealers & gas service stations	55	1.50	10	20	20	10	30	-	-	-	40	-	-	-
Eating and drinking places	58	2.00	10	200	-	20	-	-	170	-	-	-	-	-
Banking	60	1.50	-	10	-	-	-	-	-	-	-	-	-	-
Real Estate	65	1.20	-	-	-	-	-	-	-	-	-	-	-	-
Personal services	72	1.60	-	-	-	-	-	-	-	10	-	-	-	-
Misc. business services	73	1.60	-	200	-	-	-	-	-	-	-	-	-	-
Auto repair, auto services & garages	75	1.60	10	20	20	10	30	-	-	-	40	-	-	-
Misc. repair services	76	1.60	10	120	10	-	-	-	-	-	-	-	-	-
Misc. services	89	1.00	-	-	-	-	-	-	-	-	-	-	-	-
Amount salvaged (used same % as 1970)			14,750	1,040	6,270	-	-	-	-	-	-	-	-	-
Amount to landfill (used same % as 1970)			8,400	3,960	600	110	2,080	9,690	550	750	240	-	-	-
TOTALS			17,150	5,000	6,870	110	2,080	9,690	550	750	240	-	-	-

*Dashes(-) indicate quantities of less than 5 TPY

TABLE A-15
PORT OF TACOMA
SOLID WASTE PROJECTIONS FOR NON-WATERFRONT INDUSTRIES 2000
TONS PER YEAR

STANDARD INDUSTRIAL CLASSIFICATION Description	No.	Growth Factor (1970-2000)								SPECIAL WASTES				
			Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	Chemicals	Petroleum	Condemned Food	Hazardous Wastes	Other Wastes
Construction--other than building	16	2.99	10	10	10	-	-	-	-	-	-	-	-	-
Construction--special trade contractors	17	2.08	60	30	20	-	-	-	-	-	120	-	-	-
Food & kindred products	20	2.71	50	60	30	-	-	-	470	-	-	-	-	-
Textile mill products	22	1.81	-*	-	-	-	10	-	-	-	-	-	-	-
Apparel & other finished products made from fabrics	23	1.81	-	-	-	-	30	-	-	-	-	-	-	-
Lumber & wood products, except furniture	24	2.71	21,400	270	90	-	-	-	30	-	-	-	-	-
Furniture and fixtures	25	2.71	8,000	770	270	-	4,900	-	-	-	-	-	-	-
Paper & allied products	26	2.35	390	1,950	70	-	-	-	10	-	-	-	-	-
Chemicals and allied products	28	2.71	200	390	120	-	-	270		-	-	-	-	-
Petroleum refining & related industries	29	2.53	-	250	510	-	-	8,850	-	-	-	-	-	-
Rubber & misc. plastics products	30	2.35	20	730	-	-	750	-	-	950	-	-	-	-
Stone, glass, clay & concrete products	32	2.71	30	-	-	-	60	-	-	50	-	-	-	-
Primary metal industries	33	2.35	-	-	-	-	-	8,250	-	-	-	-	-	-
Fabricated metal products	34	2.17	140	300	20	-	-	-	-	-	-	-	-	-
Machinery, except electrical	35	2.71	80	230	1,630	-	-	50	-	-	-	-	-	-
Electrical machinery	36	2.71	40	50	240	-	30	-	-	-	-	-	-	-
Transportation equipment	37	2.71	40	30	30	-	10	-	-	70	-	-	-	-
Misc. manufacturing industries	39	2.71	30	30	10	-	-	-	-	-	30	-	-	-
Motor freight transportation & warehousing	42	3.25	9,850	1,730	200	-	160	70	-	200	130	-	-	-
Water transportation	44	2.89	30	60	-	-	-	-	-	-	-	-	-	-
Pipeline transportation	46	1.81	-	-	-	-	-	-	-	-	-	-	-	-
Transportation services	47	2.53	100	20	80	-	-	-	-	-	-	-	-	-
Electric, gas and sanitary services	49	2.53	-	30	-	-	-	-	-	-	-	-	-	-
Wholesale trade	50	2.35	1,230	980	9,000	130	610	-	210	20	-	-	-	-
Building, Matls., hardware & farm equipment dealers	52	3.61	-	70	-	-	-	-	-	-	-	-	-	-
Auto dealers & gas service stations	55	2.71	20	40	30	10	50	-	-	-	70	-	-	-
Eating and drinking places	58	3.61	10	360	-	40	-	-	310	-	-	-	-	-
Banking	60	2.71	-	10	-	-	-	-	-	-	-	-	-	-
Real Estate	65	2.17	-	10	-	-	-	-	-	-	-	-	-	-
Personal services	72	2.89	-	10	-	-	-	-	-	10	-	-	-	-
Misc. business services	73	2.89	-	350	-	-	-	-	-	-	-	-	-	-
Auto repair, auto services & garages	75	2.89	10	30	30	10	60	-	-	-	70	-	-	-
Misc. repair services	76	2.89	20	220	20	-	-	-	-	-	-	-	-	-
Misc. services	89	1.81	-	-	-	-	-	-	-	-	-	-	-	-
Amount salvaged (used same % as 1970)			26,500	1,870	11,310	-	-	-	-	-	-	-	-	-
Amount to landfill (used same % as 1970)			15,250	7,150	1,100	290	3,750	17,490	980	1,340	420	-	-	-
TOTALS			41,750	9,020	12,410	290	3,750	17,490	980	1,340	420	-	-	-

*Dashes(-) indicate quantities of less than 5 TPY

TABLE A-16
PORT OF TACOMA
SUMMARY OF INVENTORY QUESTIONNAIRE RESPONSE 1970
TERMINAL OPERATIONS AND RELATED ACTIVITIES
TONS PER YEAR

	Demolition Wood	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES: Chemicals	Paints & Petroleum	Condemned Food	Hazardous Wastes	Other Wastes
TERMINAL OPERATIONS: PORT OPERATED													
Cargo operations--housekeeping	-	580	135	36	x	x	x	8	x	-	-	-	-
Cold storage	-	13	9	x	x	x	-	30	-	-	-	-	-
Cool room	-	12	x	x	x	x	-	x	-	-	-	-	-
Maintenance	58	x	x	x	x	x	x	-	x	-	-	-	-
Commercial fishing marina	-	2	2	9	45	x	-	-	-	-	-	-	-
Sub-total	58	607	146	45	45	x.	x	38	x	-	-	-	-
TERMINAL OPERATIONS: LEASED													
Grain elevator	-	10	x	36	-	-	-	-	-	-	-	-	-
Bulk--alumina ore	-	-	x	x	-	-	10	-	-	-	-	-	-
Bulk--liquid	-	-	9	30	-	-	140	-	-	-	-	-	-
Frozen food processing	-	2	15	12	-	-	-	15	-	-	-	-	-
Sub-total	-	12	24	78	-	-	150	15	-	-	-	-	-
SHIPBOARD WASTE	-	10	9	66	-	-	-	1000	-	-	500	-	-
DEMOLITION WASTE(1971)	14,240	-	-	150	-	-	-	-	-	-	-	-	-
TOTALS	14,298	629	179	339	45	x	150	1053	x	-	500	-	-

Notes: (-) None or an insignificant amount is expected
(x) A significant amount is expected

TABLE A-17
PORT OF TACOMA
SUMMARY OF INVENTORY QUESTIONNAIRE RESPONSE 1970
WATERFRONT INDUSTRIES
TONS PER YEAR

STANDARD INDUSTRIAL CLASSIFICATION Description	No.	Demolition Wood	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES Chemicals	Paint & Petroleum	Condemned Food	Hazardous Wastes	Other Wastes
Construction--other than building	16	-	890	57	53	-	10	880	-	-	-	-	-	-
Lumber & wood products, except furniture	24	-	1170	8	x	-	-	-	-	-	-	-	-	-
Chemicals and allied products	28	-	13	186	230	50	-	14,950	-	x	-	-	x	200
Petroleum refining & related industries	29	-	-	-	-	-	-	-	-	x	x	-	-	-
Stone, glass, clay & concrete products	32	-	x	-	-	-	-	5,000	-	x	-	-	-	-
Primary metal industries	33	-	120	120	x	-	-	160	-	x	-	-	-	120
Transportation equipment	37	-	563	39	68	103	-	-	-	-	-	-	-	-
Motor freight transportation & warehousing	42	-	3840	4	-	x	-	-	-	-	-	-	-	-
Pipeline transportation	46	-	-	1	-	-	-	-	-	-	-	-	-	-
Wholesale trade	50	-	250	250	2600	26	25	1,330	-	-	x	-	-	-
Eating and drinking places	58	-	-	x	-	-	-	-	45	-	-	-	-	-
Auto repair, auto services & garages	75	-	-	-	x	-	-	-	-	-	-	-	-	-
Marina	-	-	-	4	-	50	-	-	2	-	2	-	-	-
TOTALS		-	6846	669	2951	229	35	22,320	47	x	2	-	x	320

Notes: (-) None or an insignificant amount is expected
(x) A significant amount is expected

TABLE A-18
PORT OF TACOMA
SUMMARY OF INVENTORY QUESTIONNAIRE RESPONSE 1970
NON-WATERFRONT INDUSTRIES
TONS PER YEAR

STANDARD INDUSTRIAL CLASSIFICATION Description	No.	Demolition Wood	Wood	Paper	Metal	Glass	Fiber Plastic Rubber	Minerals	Putrescibles	SPECIAL WASTES Chemicals	Paints & Petroleum	Food		
Construction--other than building	16	-	5[1]	5[1]	5[1]	-	-	-	-	-	-	-	-	-
Construction--special trade contractors	17	-	30[1]	12[1]	11[1]	-	-	-	-	-	58[1]	-	-	-
Food & kindred products	20	-	20	21	10	-	-	-	156	-	-	-	-	-
Textile mill products	22	-	1	1	-	-	3	-	-	-	-	-	-	-
Apparel & other finished products made from fabrics	23	-	-	-	-	-	50	-	-	-	-	-	-	-
Lumber & wood products, except furniture	24	-	726[1]	80[1]	8[1]	-	-	-	-	-	10	-	-	-
Furniture and fixtures	25	-	290[1]	283	100[1]	-	700	-	-	-	-	-	-	-
Paper & allied products	26	-	161[1]	720	31[1]	-	-	-	4	-	-	-	-	-
Chemicals and allied products	28	-	10[1]	125[1]	20[1]	-	-	x	-	-	-	-	-	-
Petroleum refining & related industries	29	-	-[1]	100	200	-	-[1]	3500	-	-[1]	-	-	-	-
Rubber & misc. plastics products	30	-	10[1]	310	-	-	318[1]	-	-	420[1]	-	-	-	-
Stone, glass, clay & concrete products	32	-	10[1]	-	-	-	30	-	-	20[1]	-	-	-	-
Primary metal industries	33	-	-	-	-	-	-	3510	-	-	-	-	-	-
Fabricated metal products	34	-	66	140	9	-	-	-	-	-	-	-	-	-
Machinery, except electrical	35	-	10[1]	53	120[1]	-	-	x	-	-	-	-	-	-
Electrical machinery	36	-	14	7[1]	78	-	x	-	-	-	-	-	-	-
Transportation equipment	37	-	3	x	x	-	2[1]	-	-	25	-	-	-	-
Misc. manufacturing industries	39	-	10[1]	10	3	-	-	-	-	-	10[1]	-	-	-
Motor freight transportation & warehousing	42	-	30[1]	30	50[1]	-	50[1]	x	-	60[1]	40	-	-	-
Water transportation	44	-	1	10	1	-	-	-	-	-	-	-	-	-
Pipeline transportation	46	-	-	1	-	-	-	-	-	-	-	-	-	-
Transportation services	47	-	40[1]	9[1]	30[1]	-	-	-	-	-	-	-	-	-
Electric, gas and sanitary services	49	-	-	x	-	-	-	-	-	-	-	-	-	-
Wholesale trade	50	-	466[1]	315[1]	600[1]	50	20	-	79	x	-	-	-	-
Building, materials, hardware and farm equipment dealers	52	-	-	19	-	-	-	-	-	-	-	-	-	-
Auto dealers & gas service stations	55	-	6[1]	14[1]	10[1]	3[1]	20[1]	-	-	-	85[1]	-	-	-
Eating and drinking places	56	-	3[1]	100[1]	1[1]	10[1]	-	-	85	-	-	-	-	-
Banking	60	-	-	x	-	-	-	-	-	-	-	-	-	-
Real Estate	65	-	-	3	-	-	-	-	-	-	-	-	-	-
Personal services	72	-	-	2	1	-	1[1]	-	-	3[1]	-	-	-	-
Misc. business services	73	-	-	120[1]	-	3	-	-	-	-	-	-	-	-
Auto repair, auto services & garages	75	-	5[1]	10[1]	10[1]	-	20[1]	-	-	-	25[1]	-	-	-
Misc. repair services	76	-	5[1]	61[1]	2[1]	-	-	-	-	-	-	-	-	-
Misc. services	89	-	-	2	-	-	-	-	-	-	-	-	-	-
TOTALS		-	11,131	2563	1300	66	1214	7010	324	528	168	-	-	-

Notes: (-) None or an insignificant amount is expected
(x) A significant amount is expected or the sum total of all the industries in this category is significant
(1) Approximated from data recieved & classified as mixed industrial waste or otherwise combined before May also include properly classified data

TABLE A-19
PORT OF TACOMA
DENSITY CALCULATIONS FOR CONVERSION OF DATA IN TONS TO CU YD

Type of Waste	Compressed to Solid Density				Uncompacted Density			Compacted Density	
	sp gr	lb/cu ft	cu ft/ton	lb/cu yd	lb/cu yd	T/cu yd	cu yd/ton	T/cu yd	lb/cu yd
Steel	7.70	480	4.1	12,950	6,000	3	0.33	5	10,000
Aluminum	2.70	168	11.9	4,530	2,000	1	1	2	4,000
Glass	2.50	156	12.8	4,200	2,000	1	1	1.5	3,000
Paper (avg)	0.96	60	33.4	1,620	200	0.1	10	0.5	1,000
Cardboard	0.69	43	46.5	1,160	200	0.1	10	0.4	800
Wood	0.60	37	54.0	1,000	200	0.1	10	0.45	900
Plastics (avg)	1.14	71	28.1	1,915	400	0.2	5	0.75	1,500
Fibers (about)	0.8	50	40.0	1,350	200	0.1	10	0.5	1,000
Rubber	1.0-2.0	90	22.2	2,430	500	0.25	4	1.0	2,000
Leather (avg)	0.96	60	38.3	1,620	500	0.25	4	0.75	1,500
Paints, Petrol	0.96	60	33.3	1,620	1,620	0.8	1.25	0.8	1,620
Garbage	0.96	60	33.3	1,620	300	0.15	6.6	0.5	1,000
Clay	1.8-2.6	162	12.3	4,380	3,040	1.52	0.65	1.5	3,000
Chemicals (about)	1	63	31.8	1,700	1,200	0.6	1.67	0.75	1,500
Nonseparated Refuse (about)					200	0.1	10		
Concrete (about)					2,000	1.0	1		

TABLE A-20
PIERCE COUNTY
ESTIMATED QUANTITIES OF SOLID WASTE
TONS PER YEAR

Year	City of Tacoma				Pierce County Less City of Tacoma			Total for Pierce County
	City Waste	County Waste	Port of Tacoma[1]	Total	Military Disposal Sites	Other County Disposal Sites	Total	
1970	112,400	14,700	47,170	174,270	39,000	84,000	123,000	297,270
1980[2]	151,000	19,700	83,530	254,200	52,000	113,000	165,000	419,200
2000[2]	272,000	35,600	133,650	441,650	95,000	204,000	299,000	740,650

1/ Pier Demolition waste excluded.

2/ Pier Projections based on 1970 data x 3% annual growth factor.

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